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BORING LOCATION - FIG. 3.1 ; STATIC & SEISMIC STABILITY ANALYTICAL RESULTS - FIG. 5 & 7

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January 22, 2001

Kevin Turner-Environmental Scientist, OSC
U. S. Environmental Protection Agency
8588 Rt. 148
Marion, IL 62959

**Re: Sauget Sites Area I - May 31, 2000 Unilateral Administrative Order
Docket No. V-W-99-C-554
Dead Creek Sediments & Soils Removal / Containment**

- **Time Critical Removal Action Work Plan**
- **Response to Comments - Part III (Under separate cover)**

Dear Mr. Turner,

On May 31, 2000 the United States Environmental Protection Agency ("U. S. EPA") issued a Unilateral Administrative Order ("Order") to Monsanto Company and Solutia Inc. ("Solutia") requiring removal of soils and sediments from Dead Creek and placement within a containment cell. On June 30, 2000 Solutia submitted for U. S. EPA's approval, a Time Critical Removal Action Work Plan ("TCRAWP") pursuant to the Order. On August 14, 2000, Solutia received your August 10, 2000 letter containing U. S. EPA's comments on the TCRAWP, along with additional comments from the Illinois Environmental Protection Agency ("IEPA"), except for Mr. Robert Watson; Illinois Department of Natural Resources ("IDNR"); and the U. S. Fish and Wildlife Service. Mr. Robert Watson's comments were received by Solutia via email on August 31, 2000.

Pursuant to agreements reached in an October 11, 2000 meeting of all parties to discuss the comments on the TCRAWP, Solutia's Response to Comments - Part I was submitted to the Agencies on October 27. This initial response to comments contained responses to all comments from your August 10, 2000 letter. Response to Comments - Part II was submitted to the Agencies November 3 and contained responses to an agreed-to subset of Mr. Watson's comments, including Solutia's "Group 1" responses and all of Mr. Watson's "musts" comments. Mr. Watson's "musts" list of comments were communicated to Solutia at an October 11, 2000 meeting.

On November 22, 2000, Solutia received comments from Mr. Watson on its Response to Comments - Part II. These comments - which I will refer to as "Group II" - were discussed in a November 29, 2000 conference call involving you and Mr. Watson along with myself, Gary Wantland and Richard Williams. All parties had previously agreed that U. S. EPA approval of Response to Comments - Part II would provide sufficient certainty of the containment cell design to allow completion of a Request for Proposal ("RFP") by Solutia. During the November 29, 2000 call, only the Group II comments judged to most directly affect the containment cell RFP were discussed. These comments were Nos. 12, 24(d, f & g), 57, 61, 78 and 84. At the conclusion of the call, all parties agreed that sufficient understanding and agreement had been reached such that the RFP process could proceed. It was further agreed that Solutia's formal response to the Group II comments would follow at a later date. Response to Comments Part II - Group II were submitted to the Agencies January 15, 2001.

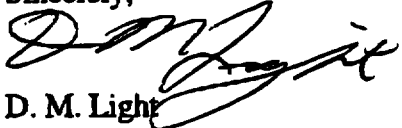
This Response to Comments - Part III (sent under separate cover for 01/23/01 delivery) contains responses to all remaining comments from Mr. Watson not already addressed in Response to Comments - Parts I, Response to Comments Part II and Response to Comments Part II - Group II. Comments addressed in this Response to Comments - Part III are:

<u>1 to 9</u>	<u>10 to 19</u>	<u>20 to 29</u>	<u>30 to 39</u>	<u>40 to 49</u>	<u>50 to 59</u>	<u>60 to 69</u>	<u>70 to 79</u>	<u>80 to 87</u>
15	22	35	45	59	60	72	83	
17	23	36	46		63	73	85	
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19	26	38				77		
	27					79		

Since the November 29th call when sufficient understanding and agreement was reached such that the RFP process could proceed, Solutia has prepared and submitted the containment cell RFP to five contractors. Four of the five contractors have indicated they would submit bids. The bids are now due back to Solutia by January 29, 2001, after having granted a one week extension at the request of the bidders. Upon receipt of the bids, Solutia will review and discuss the proposals with each contractor. We expect to be prepared to select the contractor and award a contract by March 1, 2001, pending receipt of final U. S. EPA approval of the TCRAWP. It has been Solutia's experience that the selected contractor would then likely require approximately one month to be mobilized to the site.

Therefore, with no delays, field work could begin approximately April 1, 2001. It is important that field work start as early as possible in 2001 in order to complete construction activities within the next construction season. Solutia appreciates your prompt attention to all Response to Comments and receipt of final U. S. EPA approval of the containment cell Time Critical Removal Action Work Plan..

Sincerely,



D. M. Light
Project Coordinator
Solutia Inc.

cc: (w/enclosure)

Thomas Martin, Esq. - U. S. EPA
Michael McAteer - U. S. EPA
Candy Morin - IEPA
Robert Watson - IEPA
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cc: (w/o enclosure)

Bruce Yare - 6S
Mike Foresman - 6S
Steve Smith - 6S

Time Critical Removal Action Work Plan

Dead Creek Sediment and Soil
Sauget and Cahokia, Illinois

Response to Comments (Part III)

DRAFT

January 22, 2001

Submitted to:

US Environmental Protection Agency
Chicago, Illinois

Submitted by:

Solutia Inc.
St. Louis, Missouri

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ATTACHMENTS

Attachment 1	Figure 3-1: Boring Location Plan (Revised)
Attachment 2	Figure 3-5: Geologic Cross Section
Attachment 3	Figure 3-4: Bedrock Elevation Map
Attachment 4	Revised Geotechnical Investigation for Sauget Area I Landfill
Attachment 5	Surficial Soils Bearing Capacity (Revised)
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Attachment 12	Geotextile Clogging Potential Evaluation
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Attachment 14	Figure 5-3: Typical Cover Vent
Attachment 15	Revised Geosynthetic CQA Manual
Attachment 16	Revised Cover System Hydraulic Calculations

INTRODUCTION

On May 31, 2000 USEPA issued a Unilateral Administrative Order (UAO) requiring removal of soils and sediments from Dead Creek and placement of excavated material in an on-site containment cell. Solutia submitted a Time Critical Removal Action Work Plan (TCRAWP), also required by the Order, on June 30, 2000. This Work Plan was organized as follows:

Section 1.0	Introduction
Section 2.0	Site Description
Section 3.0	Sediment Chemical Analyses and Bioassays
Section 4.0	Sediment and Soil Removal Plan
Section 5.0	Sediment Handling, Dewatering and Treatment Plan
Section 6.0	Storm Water Management Plan
Section 7.0	Excavated Area Soil Sampling Plan
Section 8.0	Creek Segment B Liner Installation Plan
Section 9.0	Containment Cell Design Report
Section 10.0	Schedule

On August 14, 2000, Solutia received USEPA's, IEPA's, Illinois Department of Natural Resources' (IDNR), and U. S. Fish and Wildlife Service's (USFWS) comments on the TCRAWP.

Additional IEPA comments on the Containment Cell Design Report were received by Solutia on August 31, 2000. Although IEPA numbered its comments 1 through 87, there were actually 131 comments. Multiple comments were included in a single comment number, e.g. Comment 24 a, b, c, d, e, f and g, resulting a higher comment total than indicated by the comment numeration.

To facilitate preparation of a response to comments document and a containment cell construction bid package, Solutia organized IEPA's August 31, 2000 comments on the Containment Cell Design Report into ten groups:

Group 1	Design, Specifications and CQA Plan Improvements (38 Comments)
Group 2	No Improvement in Design, Specifications and CQA (29 Comments)
Group 3	Design Calculations (25 Comments)
Group 4	Design Report Revisions (13 Comments)
Group 5	Additional Site Characterization (7 Comments)
Group 6	Technically Impracticable (7 Comments)
Group 7	Did Not Understand (5 Comments)
Group 8	Regional/Historical Information (2 Comments)
Group 9	No Response Required (2 Comments)
Group 10	Miscellaneous (3 Comments)

This breakdown, and an action plan for addressing these comments, was sent to USEPA on September 25, 2000. In the action plan, Solutia agreed to incorporate the 38 Group 1 comments into the Design Report immediately and issue a bid package based on the revised document. Group 1 comments included:

<u>1 to 9</u>	<u>10 to 19</u>	<u>20 to 29</u>	<u>30 to 39</u>	<u>40 to 49</u>	<u>50 to 59</u>	<u>60 to 69</u>	<u>70 to 79</u>	<u>80 to 87</u>
6	13	24g	32a	40	51	61	74	80
7	14		32b	41	53	62	75	86a
8			32c	42a	54	66	78	86b
			32f	43	55	67		
			33c	48	56	68		
			34a	49	57	69		
			34d		58			

On October 10 and 11, 2000, a meeting of all parties was held to discuss the comments on the TCRAWP. During this meeting, IEPA's list of 60 "must have" comments was communicated to Solutia. These comments are listed below:

<u>1 to 9</u>	<u>10 to 19</u>	<u>20 to 29</u>	<u>30 to 39</u>	<u>40 to 49</u>	<u>50 to 59</u>	<u>60 to 69</u>	<u>70 to 79</u>	<u>80 to 87</u>
1	10	20	30	40	50	61	70	80
2	11	21	31	41	51	62	71	81
3	12	24	32	42	52	64	74	82
4	13	28	33	43	53	65	75	84
5	14	29	34	44	54	66	78	86
6	16		39	48	55	67		
7				49	56	68		
8					57	69		
9					58			

As agreed at the October 10 and 11, 2000 meeting, Solutia is responding to the Agencies comments with three submittals. Response to Comments (Part I), which addressed the August 10, 2000 comments, was submitted to the Agency on October 27, 2000. Response to Comments (Part II) submitted to the Agencies November 3, 2000 addressed Solutia's Group 1 comments and IEPA's "must have" comments on the Containment Cell Design Report. This Response to Comments (Part III), addresses the remaining 27 IEPA comments on the Containment Cell Design Report, which include:

Time Critical Removal Action Work Plan

Dead Creek Sediment and Soil

Containment Cell Design

RESPONSE TO COMMENTS (GROUP III)

<u>1 to 9</u>	<u>10 to 19</u>	<u>20 to 29</u>	<u>30 to 39</u>	<u>40 to 49</u>	<u>50 to 59</u>	<u>60 to 69</u>	<u>70 to 79</u>	<u>80 to 87</u>
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SPECIFIC COMMENTS

Liner System Description

15. Section 4.1.5, Liner System Exposure Prevention: Section 4.1.5 of Appendix 7 in the design report does [not] describe how the liner system (especially the geomembrane layers) will be protected from the wind. This can either be done by placing the soil/sand layers on the geomembrane quickly (e.g. same day) after it is installed, or by temporarily placing sand bags on it.

Response:

Section 4.1.5 of Appendix 7 in the Design report will be modified to address protection from potential wind damage. A new paragraph will be added to incorporate the option of placing temporary sandbags or placement of the next layer of geosynthetic material as indicated below:

Modify first paragraph

"Certain synthetic components in the proposed lining system can be injured by various environmental exposures. Two potentially damaging environmental exposures are sunlight and wind. Sunlight can degrade unprotected plastics and polymers. Wind can displace and damage placed materials due to uplift causing pinholes, wrinkles and weakened locations at folds. The HDPE membrane linings.....

Add a new paragraph

"Wind damage to the geosynthetic liner systems is another potentially significant problem resulting from exposure to the elements. Damage to geosynthetics is typically due to displacement after the material has been installed. Prevention of this potential damage will be managed by placement of the succeeding soil / sand layer on the base of the landfill and via the use of sandbags on the side slopes of the cell.

FOUNDATION

17. Section 3.0, Site Characterization: The proposed location of the containment cell needs to be shown relative to the borings on Figure 3-1.

Response:

Figure 3-1 has been modified to present the location of the containment cell relative to the borings performed for design as requested. This revised drawing is included as Attachment 1 to this Response to Comments.

18. Section 3.0, Site Characterization: Geologic cross sections from the surface down to the confining layer (bedrock) need to be provided. The location and elevations of the proposed containment cell needs to be shown on these cross sections.

Response:

Geologic cross-sections from the surface down to the confining layer (identified as Figure 3-5) is provided as Attachment 2 to this Response to Comments. The relative location and elevation of the containment cell is shown on the figure.

19. Section 3.0, Site Characterization: Piezometer PZ-1, and the three GB borings, all end in the sand layer (either SM or SP). None of the borings continues to the top of a confining layer (which may be bedrock at this site). The design report needs to characterize the geology from the surface down to the first confining layer. This requirement can be met by either providing a the boring log report for an existing boring near the site that extends down to a confining layer, or by installing an additional boring at the site that extends a confining layer.

Response:

Information on characterization of site geology from ground surface to the first confining layer was provided in the Time Critical Removal Action Plan for Dead Creek Sediment and Soil in Section 2.6. Section 3.0 of the Design Report will be modified to include this information as described below:

“Section 3.5 GEOLOGIC CHARACTERIZATION

The Mississippi River floodplain contains unconsolidated valley fill deposits composed of recent alluvium (Cahokia Alluvium), which overlies glacial material identified as the Henry Formation. The Cahokia Alluvium (recent deposits) consists of unconsolidated, poorly sorted, fine-grained materials with some local sand and clay lenses. These recent alluvium deposits unconformably overlie the Henry Formation which is Wisconsinian glacial outwash in the form of valley-train deposits. The Henry Formation is about 100 feet thick. These valley-train materials are generally medium to coarse sand and gravel and increase in grain size with depth. Unconsolidated deposits are underlain by bedrock of Pennsylvanian and Mississippian limestone and dolomite with lesser amounts of sandstone and shale. Figure 3-4 presents a surface map of the bedrock surface within the East St. Louis area. The approximate location of the site is included in that figure. Figure 3-5 presents a cross section of the site from ground surface to bedrock. The relative location of the containment cell is included in that cross section.”

Figure 3-4 is included as Attachment 3 to this Response to Comments.

ENGINEERING ANALYSES

22. Section 4.2.2, Bearing Capacity: Section 4.2.2 states that undrained shear strengths were determined for the surficial clays and silts. However, the test results provided in Appendix B show that clay only made up the top 1 inch (of a 6 inch sample) for one of the three unconfined compression tests. Therefore, this section needs to be revised to reflect that the undrained shear strength is only known for the silts under the site. Conversely, additional testing could be done on the surficial clay to determine its undrained shear strength (this is the preferred option).

Response:

Solutia has completed an additional site investigation to delineate the surficial soils and characterize their material and engineering properties. This second investigation, which updates and replaces the previous site investigation, is included in Attachment 4 to this Response to Comments. The information collected by this second field and laboratory investigation will be included as Appendix A of the final design report.

As shown in Attachment 4 the included report incorporates the data and results of the first site investigation performed in December 1999. Shear strength data was collected for the surficial clay and silt strata from the second investigation. As presented in the report (Table1- Summary of Data for Key Strata) material and engineering characteristic properties for these materials has been characterized.

23. Section 4.2.2, Bearing Capacity: Section 4.2.2 needs to provide justification for the statement that the limiting bearing capacity strata was found to be the surficial clays and silts. Part of this justification should include providing the test results from all of the soil strata under the proposed landfill site.

Response:

As indicated above Solutia elected to perform additional site investigations to further characterize the material and engineering properties of the surficial soils beneath the proposed landfill. This additional information is included as Attachment 4 to this Response to Comments and will be included in Appendix B of the final design report. Using the recently collected information the bearing capacity of the surficial clays and silts was recalculated. That updated calculation is included as Attachment 5 to this Response to Comments.

Based on this information the text of Section 4.2.2 of the final design report will be modified to read as follows:

Section 4.2.2 Bearing Capacity

The surficial clay and silt samples collected at the site were found to have undrained shear strengths ranging from 250 to 440 pounds per square foot (psf). Those strengths indicate soils with soft to firm consistency. The underlying sandy soils were observed to be very loose to medium dense. The limiting bearing capacity strata was found to be the surficial clays and silts. Based on the minimum undrained shear strength above, the

ultimate bearing capacity of the existing subgrade soils is about 1,300 psf. Details of this evaluation are presented in Appendix B.”

25. Section 4.2.6, Potential for Excess Hydrostatic or Gas Pressure: The design report needs to include calculations [to] demonstrate that the weight of the completed landfill will be greater than the hydrostatic uplift pressure.

Response:

The requested calculations are included as Attachment 6 to this Response to Comments. In addition, this calculation will be added to Appendix B. Section 4.2.6 of the design report will be modified to read as follows:

“Section 4.2.6 Potential for Excess Hydrostatic or Gas Pressure

Excess hydrostatic or gas pressure is not expected to affect the containment cell. The highest groundwater elevation observed at the site was over 8 ft below the proposed secondary lining elevation. The maximum flood elevation for this area is reportedly elevation 406. After the lining system is complete, the static weight of the soil layers in the lining system exceeds the potential hydrostatic uplift pressure. No heaving of the lining system is anticipated. Calculations demonstrating this point are included in Appendix B.

The potential for gas pressure within the containment cell is low due to the relatively low quantity of decomposable matter in the wastes compared to a sanitary waste landfill. A venting system will be incorporated into the cover system to vent excess gas or barometric pressure from within the containment cell.”

SYNTHETIC LINERS

26. Section 7 Material Compatibility Studies: This section needs to indicate the approximate date the compatibility testing will be concluded and results provided to USEPA and IEPA.

Response:

The study commissioned by Solutia to evaluate compatibility of the materials proposed to construct the Sauget Area 1 containment cell is now complete. This investigation demonstrates that the proposed materials are suitable for the intended use. The results of this study are included as Attachment 7 to this Response to Comments. This information will be incorporated into the final design report as Appendix H.

27. Section 4.3.2, Synthetic Liner Strength: Section 4.3.2 makes a number of statements regarding the strength of the liner that are not justified in the narrative. The narrative needs to provide specific numbers and refer to specific calculations (not just the Appendix) and technical data sheets on the materials in order to justify conclusions such as the following:

- The synthetic linings in the containment cell will not be subject to significant tensile stresses.

- The side slope linings will not be overstressed.
- The longitudinal seams are not expected to be significantly loaded.
- The strain in the bottom lining due to settlement is well within the elastic limit for the HDPE lining.
- It appears the bottom linings will not be overstressed.

Response:

Information on synthetic liner strength performance was submitted with the response to the Group II Comments. Detailed calculations were provided in Attachment 6 of the Response to Comments - Group II. These calculations will be included in Appendix C of the final design report. Calculations on the induced strain in the geomembrane due to settlement of the landfill after construction and waste material placement is included as Attachment 8 to this Response to Comments and will be included in the final design report.

Section 4.3.2 of the final design report will be modified as shown below.

"Section 4.3.2 Synthetic Liner Strength

Two loading conditions are anticipated for the synthetic linings, soil loading on side slopes and settlement of the bottom liner system. Calculations were performed to evaluate these two conditions.

The linings on the cell's side slopes will be insulated from downdrag from the overlying waste material by a geonet drainage composite. Calculations in Appendix C (Lining Tensile Stress) for the lining stress due to the weight of soil sliding down the side slope show that the lining stress stays below the HDPE yield stress. Once wastes are placed and compacted in the cell, little down slope soil movement will be possible. This further limits the probability of lining downdrag. The cell construction specifications will prohibit dumping soil down unprotected side slopes. Where placement traffic on the side slope is required, the slope will be protected by geogrid reinforcements and additional HDPE fly sheets. As presented in Appendix C the side slope lining stress will be less than the yield stress of the HDPE geomembrane liner material. Lateral seams in the lining panels will be prohibited on the side slopes.

Settlement of the bottom lining was previously identified to be minor. The strain in the bottom lining due to settlement as presented in Appendix C is well within the elastic limit for the HDPE lining. Settlement calculations in Appendix A and Appendix B of the final design report indicate that differential settlement of the base of the containment cell after construction and waste placement will be approximately 2 inches. This translates into an elongation in the HDPE of approximately 1.3×10^{-5} in/in. Assuming an HDPE modulus of 30,000 psi the stress increase in the bottom lining is expected to be about 30 psi for each 0.1 percent strain. These values are far less than the yield strain of 13 percent for the geomembrane. As demonstrated in Appendix C the bottom linings will not be overstressed.

Synthetic lining seaming will be performed using either hot-wedge or extrusion welding. Either method will be required to provide a film-tearing bond (FTB) in the parent HDPE

linings. The strength of these seams will be required to achieve at least 90 and 50 percent of the HDPE lining tensile strength in shear and peel, respectively. The seams will be destructively tested periodically as provided in the Construction Quality Assurance Plan. All seams will be tested for hydraulic integrity using vacuum, air-pressure, or electrical methods. Appendix C presents details of this analysis."

LINER SYSTEM, LEACHATE COLLECTION AND DETECTION SYSTEM

35. Section 4.5.2, Equivalent Capacity: Section 4.5.2 only states that the geonet transmissivity will be greater than 12 inches of sand with a hydraulic conductivity of 1×10^{-2} cm/sec. It needs to refer to copies of manufacturer's data sheets provided for the geonet, and calculations that demonstrate this statement is correct.

Response:

Calculations demonstrating that the geonet transmissivity will be equivalent to or greater than 12 inches of sand are included as Attachment 9 to this Response to Comments and will be incorporated in the final design report. These calculations refer to manufacturer's data sheets for a geonet material.

Section 4.5.2 of the final design report will be modified as follows:

"Section 4.5.2 Equivalent Capacity of Geonet Drainage Composite

The geonet drainage composite used for all side slope collection layers and the leak detection bottom layer will have transmissivity values that are equivalent to that of a 12 inch thick sand layer with a hydraulic conductivity of 1×10^{-2} cm/sec. As demonstrated in Appendix C the geonet transmissivity is almost 2 orders of magnitude greater than the transmissivity of a sand layer."

36. Section 4.5.3, Grading and Drainage: This section needs to include additional detail regarding the grading and drainage for the proposed landfill. Specifically:
- The description of the leachate collection system needs to include a demonstration of why perforated pipes are not included as part of the lateral leachate collection system on the bottom of the landfill.
 - The narrative needs to discuss how the collected leachate will be disposed. Indicate the appropriate permits which will need to be obtained. As a newly generated waste, Monsanto/Solutia will need to determine if it is a hazardous waste. If it is a hazardous waste, storage of it for greater than 90 days is subject to the RCRA storage requirements.

Response:

- The leachate collection system is designed based on the permeability of the sand and gravel of the collection layer without relying on pipes. This was achieved by selecting a combination of bottom slope, material permeability and length of collection system drainage path. The relative size of the proposed containment cell makes this disposal

unit well suited to the leachate collection designed. Calculations demonstrating this are included as Attachment 10 to this Response to Comments. The text of Section 4.5.3 of the final design report will be modified as shown below.

- b. A description of the methods proposed for collection and disposal of leachate will be provided in the final version of the design report. Applicable rules and regulations will be met in the management of these fluids. The text of Section 4.5.3 will be modified as shown below.

"Section 4.5.3 Grading and Drainage

The bottom lining for the leachate collection system will slope at 3 percent beneath the sand layer toward the gravel sump and the gravel perimeter drains. The gravel drains slope at 1 percent (minimum) to a collection sump at one corner of the cell bottom. The grading for the leak detection system generally mirrors the collection system above. As demonstrated in Appendix C, based on conservative assumptions of inflow rate, the amount of leachate head that will develop in the primary collection system is considerably less than 12 inches at the farthest point from the collection sump. This calculation demonstrates that the containment cell does not require piping to achieve the regulatory performance standard for leachate development.

The sumps will be drained through HDPE pipes placed in each sump. The collection pipe will be unperforated from ground surface down to the gravel collection sump and perforated within the gravel collection sump. The piping will match the side slope grade and bend to transition from the slope to the bottom grade. End caps will be placed over the pipe ends to prevent foreign material and gravel entry.

The pipe perforations will be 1/4-inch diameter. The entire length of piping within the gravel sump will be perforated. The 3/8-inch diameter gravel will provide adequate filter action to prevent clogging of the pipe perforations.

The HELP model results indicate that leachate production will be minimal after the cover system is in place. The transmissivity of the sand, gravel, and geonet layers are adequate to rapidly transmit the leachate to the collection sump. The leachate level in each sump will be measured by installed liquid level monitors. Any liquids found in the collection piping will be removed via sump trucks or submersible pumps and placed in drums or tanks for disposal. Collected liquids will be tested to identify the presence of hazardous constituents and disposed in accordance with applicable regulations."

37. Section 4.5.4, Maximum Leachate Head: This section needs to provide the following information to clarify the conclusions in the document:

- a. Cross sections that identify each of the layers in both HELP models.
- b. Justifications for the assumptions used in the HELP models. For example, when the amount of leachate the sediments will generate is estimated, the report should include

lab data from the field and bench/pilot scale tests regarding the moisture content of the sediments and descriptions the physical processes that will be used to dewater them before they are placed in the landfill.

- c. A description of why Layer 6 (waste sediments) is not included in the HELP model for the closed landfill, and why the average head on top of Layer 8 (the primary liner) is indicated to be 0.000 for each year. Thus, it appears the model assumes that all liquids will be squeezed out of the sediments during construction of the landfill, and no precipitation gets through the cover system. The report needs to provide additional discussion and justification for this assumption.

Response:

- a. Cross sections identifying each layer used in the HELP model are included as Attachment 11 in this Response to Comments. This figure will be included in Appendix C of the final design report.
- b. Default values from the HELP program were used for each material type evaluated in the analysis. These assumptions estimate the initial moisture content for the placed sediments to be 25 percent. Field data from investigations performed at the site indicate the average moisture content of the surficial silts and clay soils to range from 14 to 30 percent above the water table and 30 to 35 percent below the water table. Assuming normal handling during excavation from the creek, drying and preparation for placement into the containment cell, the default values used in the analysis are very reasonable.
- c. Layer 6 (waste sediments) is included in the HELP analysis for both the closed case and the construction case. The analysis indicates that practically 100 percent of the precipitation is managed by the cover system. The volume of rainfall that does not run off (for the closed landfill case) is either evaporated, transmitted via the cover drainage layer or is absorbed as soil moisture by the topsoil layer or the contained sediments.

The text of Section 4.5.4 of the design report will be modified as shown below:

"Section 4.5.4 Maximum Leachate Head

The HELP model was used to predict the leachate production and head levels within the cell during construction and after closure. The model results are shown in Appendix C.

The model results show that elevated leachate head may occur within the leachate collection layer during construction. The cell will behave like an open catchment and stormwater will collect on the waste surface. The construction model case assumed no stormwater pumping off the waste surface after rainfall events. As required by the specifications stormwater will be pumped off the waste surface as soon as possible to resume waste placement. The assumption of no surface water runoff and no pumping is therefore highly conservative. The construction model assumed that the cell was half-filled with wastes. Default values for initial soil moisture and hydraulic conductivity were used in the analysis. The maximum head in the leachate collection layer was greater than

the 12-inch maximum. Therefore, the leachate collection sump will require pump out after each rainfall event during construction. The construction model indicates the peak leachate generation rate is about 4,000 gallons per day or 2.8 gallons per minute.

The model results show that the leachate leakage into the detection layer during construction is about $\frac{3}{4}$ -inch per year, which produces about 20,000 gallons of leachate in the expected 6-month construction period or about 110 gallons per day. Therefore, the leak detection layer will require checking and possibly pump out every other day during the construction period. The analysis assumed that the head in the leachate collection layer was not drawn down regularly, therefore the leachate leakage rate is conservative.

The model results show the leachate and leak production rates fall substantially after the cover system is installed over the cell. Leachate development and leak production are essentially zero after the cell water balance has reached equilibrium. As demonstrated by the analysis water that is not managed by the cover system via evapotranspiration is absorbed by the sediments contained within the cell. Some leachate production will continue for several months after the cell is covered due to continued gravity drainage of the placed sediments, however this is expected to diminish with time. Installed liquid level controls will continuously monitor the leachate and leak collection sumps. Periodic inspections (weekly or monthly) will be conducted until the production rate has reduced. Annual checks will be conducted thereafter. "

38. Section 4.5.7 Prevention of Clogging: The following information regarding geotextiles needs to be included in the report:

- a. A sieve analysis of the waste material needs to be performed on both the sediments and the soil used in the primary liner system. This data then needs to be compared to the technical data sheet for the GCL. This is necessary in order to demonstrate the weight and apparent size opening (AOS) of the geotextile(s) is adequate for the design and will not clog.
- b. Describe how clogging would be detected and what cleanup procedures would be used to restore the capacity of the systems.

Response:

- a. It is not clear how the apparent opening size (AOS) of the GCL fabric will be effected by the grain size of the sediments and soil placed into the cell. We assume this question is intended to refer to the geotextile materials used for the leachate collection system.

Since runoff from the surrounding drainage basin will transport sediments to the creek it is reasonable to assume the surrounding soils will be representative of the sediments within the creek. Calculations of the potential for geotextile clogging were performed in the draft design report and were reported in Appendix C. These calculations assumed an 8-ounce geotextile was used to filter sediments that consisted of fine sands and silts.

Recent data collected from the site indicated that this assumption for grain size ($D_{85} = 0.7$ mm) is reasonable but the potential exists that some finer sediments may be present within Dead Creek. Grain size analyses of surficial silts and clays collected from the site indicates the distribution of fines within Dead Creek may be expected to have 100 percent of the material smaller than the #200 sieve. This distribution indicated that approximately 25 percent of the sediments are likely to be clay size fraction or smaller. Calculations using the above grain size distribution were performed to evaluate the potential for clogging the geotextile fabric. This information is included as Attachment 12 to this Response to Comments. This calculation will also be included in Appendix C of the final design report. The text of Section 4.5.7 of the final design report will be modified as indicated below.

- b. The management of clogging and description of cleanup procedures will be addressed in the O&M manual. As previously indicated, Solutia agreed to submit this document within 60 days of start of construction.

“Section 4.5.7 Prevention of Clogging

Clogging in the leachate collection and leak detection systems is unlikely to affect the performance of the systems. The systems will receive their highest loads during the waste placement with the loading expected to fall to near zero after the cover placement as reported in the Maximum Leachate Head section. The relatively short performance period for the system reduces the effect of clogging on the long-term performance of the cell.

A geotextile and 6-inch sand layer protect the underlying sand and gravel drainage layers in the leachate collection system from clogging due to the waste materials. A geotextile over the geonet drainage composite on the side slopes protects geonet from clogging with the waste materials. Clogging the geotextile on the side slope should not be a concern since the leachate will continue to flow down slope to the bottom collection layer without applying head to the lining system. Calculations indicate that the average opening size for the geotextile selected to separate the contained sediments and soils from the leachate collection system is appropriate for the expected grain size of the Dead Creek sediments.

The hydraulic capacity of the leachate collection and leak detection systems is many times greater than the highest demand placed on the layers. Minor clogging is not expected, but the capacity of the systems should provide adequate liquid drainage. After the cell is covered, the flows are nearly zero and clogging will not significantly limit the systems' performance. An analysis of geotextile clogging is presented in Appendix C.”

LINER SYSTEM, CONSTRUCTION AND MAINTENANCE

Earthwork

45. Comments on Specification 02200, Earthwork, Section 2.4, Equipment: This section needs to include specifications for the equipment used to smooth roll the soil used for the GCL subgrade.

Response:

Specification 02200 - Earthwork, Section 2.4, Equipment will be modified to require the Contractor use a steel, smooth drum roller to prepare the compacted soil surface of the landfill prior to installing GCL material in the cell. This section of the Specification will be modified as shown below.

"Section 2.4 EQUIPMENT

1. All equipment and tools used in the performance of this work are subject to the approval of the Construction Manager before work is started.
2. Contractor shall provide compaction equipment appropriate for the material types to obtain the densities specified. At a minimum "footed" rollers are expected for compaction of fine-grained soils or cohesive fills. Smooth drum rollers or hand compaction methods may be appropriate for granular drainage material sands and gravels.
3. Contractor shall provide hand-operated compaction equipment in areas closer than 2 ft from pipes or other appurtenant structures to obtain the densities specified.
4. Contractor shall operate and maintain compaction equipment in accordance with the manufacturer's instructions and recommendations. If inadequate densities are obtained, provide larger and/or different type equipment at no cost to the Owner.
5. Contractor shall provide equipment for applying water of a type and quality adequate for the Work, free of leaks and equipped with a distributor bar or other approved device to ensure uniform application.
6. Contractor shall provide equipment for mixing and drying out material, such as blades, discs, or other approved equipment.
7. Contractor shall sufficiently weigh the compaction equipment such that the feet fully penetrate the loose lift during initial compaction.
8. Contractors mixing and blending equipment shall fully penetrate loose lifts during mixing to achieve a uniform material.
9. Contractor shall provide steel drum rollers to prepare the surface of placed or compacted fill prior to placement of geosynthetic materials."

46. Specification 02200, Earthwork, Section 3.6, Placement: This section needs to be revised to address the following comments:

- a. Section 3.6.A.4. states that "differences in elevation for materials placed and compacted shall not exceed four feet . . ." Since material should not be placed in lifts in excess of eight (8) inches, this 4 foot difference seems excessive. The basis for a four (4) foot difference needs to be provided, and the specification revised as necessary to clarify its intent.
- b. Section 3.6.B.9. states lift thickness shall be controlled by the contractor through the use of grade stacks. This by itself is not adequate. The maximum depth of a loose lift needs to be specified in the specification. In general, the maximum depth of a loose lift should not be greater than eight (8) inches.
- c. Section 3.6.C.8 states the density of the tracked in place soil shall be no less than 90% of the maximum Standard Proctor dry density. However, other parts of the document state this layer will not be compacted. The portions of the Design Report that discuss this soil layer need to be revised as necessary to insure the document is consistent.

Response:

- a. Our experience with linear earthfill structures (berms, dams, etc.) indicates that differences in fill levels greater than four feet will create a potential vertical face in the embankment. That vertical face can become a seepage migration pathway, a preferential failure surface location or a weakened zone of fill with a tendency to crack. This is true even if the material was placed and compacted in lifts. Section 02200 – Earthwork was revised to reflect that the portion of the specification cited above only applies to the fill placed for the embankment and not to any specific lift. The proposed change to the wording of Specification 0200 Section 3.6.A is given below.

"4. Contractor shall place and compact all materials to prevent constructed discontinuities in the fill or segregated areas of the work. Differences in elevation for segments of Compacted Fill shall not exceed four (4) ft unless otherwise approved in writing by the Construction Manager. Individual lifts are required to be placed and compacted per Section 3.6.B of these Specifications."

- b. Maximum loose lift thickness is required by Specification 02200 – Earthwork. Section 3.6.B.5 identifies the requirement for 12-inch thick loose lift thickness during placement. This was included in the draft version of the design report.
- c. The design report and Specifications have been modified to consistently require 90 percent of the maximum Standard Proctor dry density for tracked-in-place fill. Section 4.1.1 Paragraph 6 of the final design report will be modified as shown.

"A geonet synthetic drainage composite will be installed over the secondary lining system to serve as the leak detection layer. A nonwoven geotextile will be placed over the geonet to prevent soil intrusion into the leak detection layer. The hydraulic transmissivity of geonet is at least 3×10^{-1} centimeters squared per second (cm^2/sec). At least 12 inches of native soil will be tracked in place over the leak detection layer on the cell bottom and compacted to 90 percent of the

maximum dry density indicated by the Standard Proctor test. The native soil layer will not be installed on the containment cell side slopes."

47. Specification 02200, Earthwork, Section 3.10, Quality Control: Item A.10 requires data to be sealed by a Florida registered P.E. The section needs to be revised to reference an Illinois registered P.E. In addition, URS/Monsanto/Solutia need to review the entire document to insure references to Florida requirements are removed from the document.

Response:

Specification 02200 Section 3.10.A.10 has been modified to require an Illinois registered P.E. seal all data. The revised section is presented below.

- "10. Contractor shall submit all preconstruction and construction quality control data with a cover letter signed and sealed by an Illinois registered professional engineer indicating the requirements of the Specifications have been achieved and the data as presented is representative of the material tested."

GCL

59. Specification 02245, GCL, Section 3.4 Anchor Trench: The Figures/details of the liner system show the ends of the liner system laid out horizontally in the berm, not in an anchor trench. The application needs to be revised to consistently identify how the liner system will be anchored. It is recommended that an anchor trench be used to hold the liner system in place.

Response:

The system used to secure the liner systems at the crest of the slope is based on standard design principals for anchor systems. The shape of the anchor "trench" in this case was based on efficient construction methods and control of stormwater during construction. As presented in the design report the anchor system provides the required amount of resistance for pullout and prevention of movement both during installation of geosynthetic materials and during placement of sediments into the cell.

60. Specification 02245, GCL: This specification does not include a section on Quality Control.

Response:

The revised Specification 02245 – Geosynthetic Clay Liners with requirements for Quality Control is included as Attachment 13 to this Response to Comments. This revision will be included in the final design report.

Gas Venting System

63. Gas Venting System: Appendix E and Appendix F do not appear to include any specifications for the materials used to vent gasses from the landfill, or the procedures to install these devices through the cover system.

Response:

Specifications for the materials and requirements for construction of the gas vents in the landfill cover are presented on the drawings. Attachment 14 presents Figure 5-3 from the draft design report with the requested information. This same figure will be included in the final design report.

CONSTRUCTION QUALITY CONTROL PROGRAM:

CQAP Installation of Geosynthetic Components Appendix F

72. Seaming Geomembranes: Section 2.5.2, Acceptable Seaming Methods: As noted in the comments on the Specifications for geomembranes, this section needs to specify that the CQA consultant is responsible for insuring the use of extrusion welds will be minimized.

Response:

The revised Construction Quality Assurance Manual for the Installation of Geosynthetic Components is included as Attachment 15. This CQA manual is consistent with the requirements of the Specifications for geomembrane seaming.

73. Conformance Testing for Geonets: Transmissivity should be included as a conformance test in Section 4.2.

Response:

As presented in Attachment 15 transmissivity is now included as a required conformance test in Section 4.2 of the Geosynthetic CQA manual.

CQAP Installation of Soil Components Appendix G

76. CQA Manual, Soil Components, Appendix G, Section 4.2.3: The Soil Selection Criteria for each soil component needs to include measurement of the thickness of each soil component.

Response:

The selection criteria defined in the CQA manual for soil components is intended to facilitate selection of the appropriate soil to be used in construction of each component of the landfill. Material thickness is not part of that consideration. Material thickness is currently included in Specification 02200 - Earthwork, Section 3.0 under material placement requirements.

77. CQA Manual, Soil Components, Appendix G, Section 4.2.4: The design report needs to identify the sources of the borrow soils on a scale drawing. It also needs to describe how these areas have been used in the past (e.g. agricultural, industrial, residential, etc.).

Response:

Due to several reasons, selection of the borrow site for landfill construction is the responsibility of the Contractor. Once a potential borrow site is identified information on chemical and physical characteristics of the proposed soils will be collected. The location of the borrow site and the above mentioned test results will be included in our final documentation of the constructed facility.

79. CQA Manual, Soil Components, Appendix G, Section 4.3.3: The design report needs to clarify which component in the landfill design it considers the Low Permeability Fill.

Response:

Identification of Low Permeability Fill has been removed from the text of the design report.

LINER REPAIRS DURING OPERATION

83. Liner Repairs During Operation: The Design Report needs to describe the methods that will be used to repair any damage to the liner, which occurs while the landfill is in operation during placement of the waste (e.g. a dozer ripping the liner). This description needs to address all layers in the liner system.

Response:

Methods used to repair the geosynthetic materials during placement of sediments and soils into the cell will be the same techniques used to construct the cell. Section 6.3 has been added to the final design report to clarify this point as shown below.

"Section 6.3 Repairs during Construction

During placement of the sediments and soils into the containment cell observations will be performed to ensure no damage occurs to the geosynthetic materials. If one of the synthetic materials is damaged the contractor will be required by the Construction Manager and CQA Inspector to immediately repair the damage. The means and methods for effecting these repairs will be the same as the methods used for construction. This requirement will include implementing the CQC requirements of the Specification and the CQA plan."

RUN-OFF CONTROL SYSTEMS

Calculation of Peak Flow:

85. Peak Flow and Design of Drainage Control Structures: The calculations in Appendix D need to be revised to address the following comments regarding the stormwater calculations:

- a. The first page of the stormwater control calculations refer to a peak flow of 16 cfs, but then use 8 cfs to calculate depth of flow and velocity. The QTR-55 computer model in

indicates the peak flow for a 25 year 24 hour storm is 11 cfs. Therefore, the design calculations should use at least 11 cfs for the flow.

- b. The design of the down chute uses a depth of flow of 0.38 inches when the depth of flow in the drainage swale upstream from the chute is indicated to be 0.58 inches. The calculations need to identify how the depth of flow in the down chute was determined.
- c. The calculations for sheet flow use the amount of rainfall from a 2 year 24 hour storm. This is not acceptable. The design needs to be based on the rainfall from a 25 year 24 hour storm.

Response:

The stormwater control system and the drainage control structures were modified to address these comments. The design calculations detailing these changes are included as Attachment 16.

POST-CLOSURE REQUIREMENTS

87. Post-Closure Requirements: If the Post-Closure Requirements will be addressed in the O & M Plan, the Design Report needs to state this. Otherwise, they need to be included in the Design Report since they were included in Exhibit 2 of the UAO.

Response:

The final Design Report will identify that these issues will be addressed in the O&M plan. Section 6.4 will be added to the final design report to present this information. Section 6.4 will read as follows.

“Section 6.4 Operation and Maintenance Requirements

Post closure requirements for the landfill will be identified in the operation and Maintenance Plan to be submitted by Solutia within 60 days of the start of construction.”

ATTACHMENT 2
FIGURE 3-5: GEOLOGIC CROSS SECTION

ATTACHMENT 3
FIGURE 3-4: BEDROCK ELEVATION MAP

ILLINOIS STATE GEOLOGICAL SURVEY

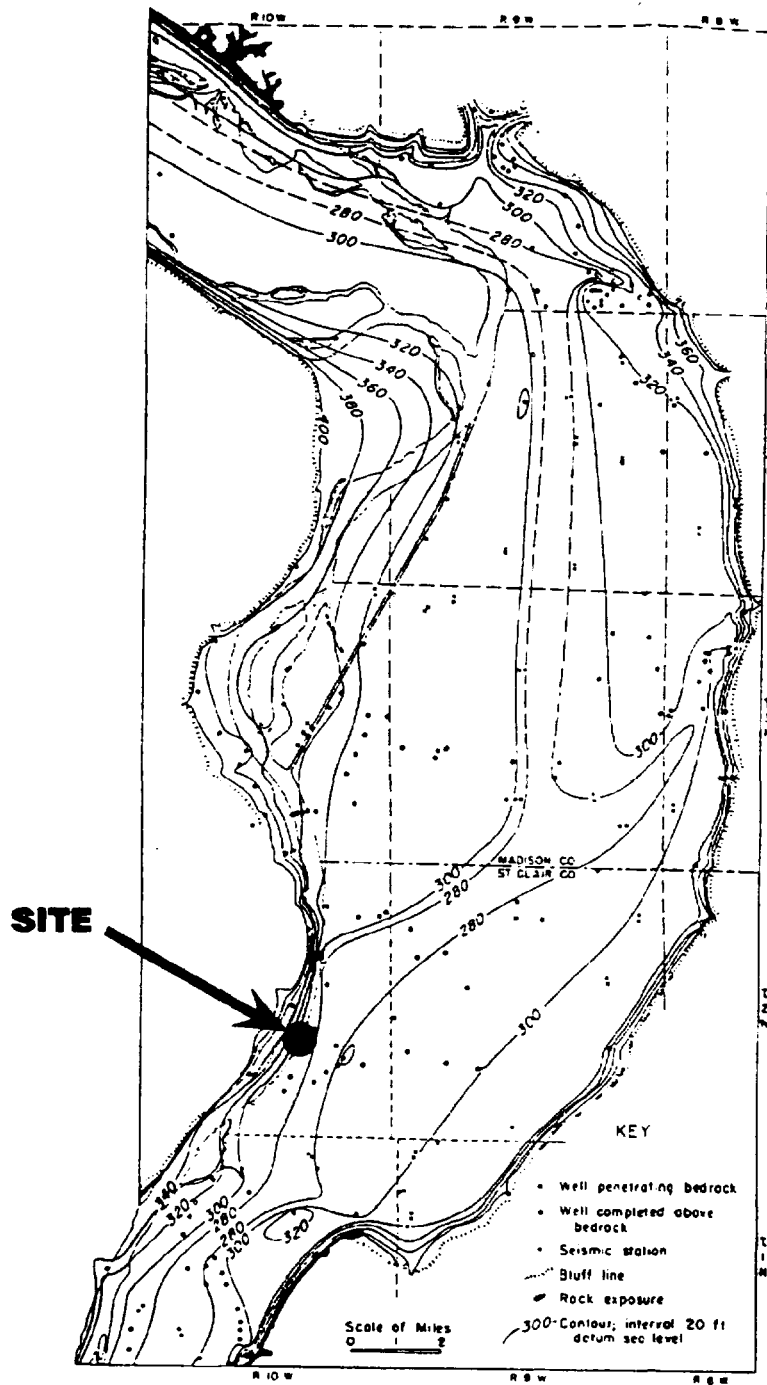


Fig. 2.—Bedrock surface map of the East St. Louis area, Illinois

REFERENCE: Map taken from Groundwater Geology of the East St. Louis Area, Illinois, R. Bergstrom and T Walker, 1956.

S:\C10000\4000\4\NEW FIGURES\F83-4.DWG 01/22/01 15:03

PREPARED FOR: SOLUTIA		PROJECT NAME		FIGURE 3-4
URSGWC JOB NUMBER: C100003899.00		Drawn:	SOLUTIA INC. SAUGET AREA 1	
URS URS Corporation Southern 7850 West Courtney Campbell Causeway Tampa, FL 33607-1462 No. 00000002		Design:	DRAWING TITLE	
		Checked: G. WANTLAND	BEDROCK ELEVATION MAP	
		Date: JAN. 22, 2001		

ATTACHMENT 4
REVISED GEOTECHNICAL INVESTIGATION
FOR SAUGET AREA I LANDFILL



December 21, 2000
23.99STL022.01

Mr. Bruce Yare
Manager, Remediation Technology
Solutia, Inc.
P.O. Box 66760
St. Louis, MO. 63166

**Subject: Revised Report of Geotechnical Investigation
For Cahokia Landfill Cell
Cahokia, Illinois**

Dear Bruce:

This letter transmits our revised report regarding the planned landfill cell in Cahokia, Illinois. This report updates and supercedes our previous report of December 2, 1999, based on two additional test borings and related laboratory testing. Findings based on the updated information are essentially similar to those presented in December of 1999, however, additional detail is provided.

We trust that this report meets your needs but will contact you shortly to discuss it.

Very truly yours,

A handwritten signature in black ink, appearing to read "William L. Durbin".

William L. Durbin, P.E.
Vice President

A handwritten signature in black ink, appearing to read "Thomas L. Cooling".

Thomas L. Cooling, P.E.
Senior Geotechnical Engineer

cc: Gary Wantland

REVISED GEOTECHNICAL REPORT

DEAD CREEK SECTOR B CONTAINMENT CELL CAHOKIA, ILLINOIS

Prepared for
Solutia, Inc.
Enterprise Engineering
575 Maryville Centre Drive
St. Louis, MO 63141



December 21, 2000

URS

URS Corporation
2318 Millpark Drive
Maryland Heights, MO 63043
(314) 429-0100
Project 2399STL022.01 00003

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This report presents results of the geotechnical investigation for Solutia's proposed landfill cell in Cahokia, Illinois. It updates and supercedes a prior report of December 2, 1999, based on two additional test borings and related laboratory tests. This work was authorized under Solutia Purchase Order 4503140217; Change Order No. 1 dated November 14, 2000.

PROJECT UNDERSTANDING

We understand that the landfill will be located on the Solutia property formerly known as the Moto property. It is planned that the northern boundary of the cell will be adjacent to the southern boundary of Site G (Figure 1) and the eastern boundary of the cell adjacent to the west bank of Dead Creek. We understand the planned cell area is on the order of about 1.4 acres. Based on drawings provided by the designer, the height of the perimeter berms will be about 16 ft above current existing grade, and the height at the center of the landfill, when capped, will be about 19 ft above the existing grade. The exterior slopes of the containment berms will be 4H:1V and the interior slopes will be 3H:1V.

FIELD INVESTIGATION AND LABORATORY TESTING

The field investigation and laboratory testing were done in two episodes; first in 1999, then in 2000.

1999 Investigation

A total of four borings were drilled and a piezometer installed on the property between November 8, 1999 through November 10, 1999. Two hand-augers borings were drilled on November 15, 1999. The geotechnical borings are designated GB-1 through GB-3, the piezometer is PZ-1, and the hand-auger borings are HA-1 and HA-2. Two borings, GB-1 and GB-3, were drilled to depths of about 50 ft and GB-2 was drilled to a depth of about 75 ft. Boring GB-2 was drilled deeper to estimate the vertical extent of loose to medium dense alluvium to help assess settlement and liquefaction potential of the site. The piezometer boring was drilled to a depth of about 20 ft and a piezometer was installed to that depth.

The borings were drilled with a CME-55 truck-mounted drilling rig owned and operated by Roberts Environmental Drilling, Inc. (REDI) of Illinois. Borings were advanced using 4-1/4 inch I.D. hollow-stem augers. Once the water table was encountered, typically at a depth of between 9 to 14 ft below ground surface, borings were continued using a 3-7/8 inch diameter roller bit and a bentonite-based drilling mud.

Soil samples were obtained from the borings using either a 1-½ inch I.D. split-spoon sampler in accordance with the Standard Penetration Test (SPT) Method (ASTM D-1586) or a hydraulically pushed thin-walled sampler (ASTM D-1587) to obtain “undisturbed” samples.

Sampling was made at 2½-ft vertical intervals in the upper 10 ft and at 5-ft vertical intervals thereafter.

2000 Field Investigation

Two additional test borings, GB-4 and GB-5 were drilled on November 17, 2000 by Harriss Drilling under technical supervision of URS. Borings were advanced with 9 inch O.D. hollow stem augers using a CME-750 drilling rig to depths of 20 feet below grade. Continuous samples were obtained using either a standard split-spoon sampler (ASTM D-1586) or hydraulically pushed thin-walled tubes (ASTM – D1587). It was originally planned to use only thin-walled tube samples, but due to the predominantly granular nature of the soil, split-spoon samples were primarily taken.

For both episodes of drilling, the borings were tremmie grouted upon completion with a cement-bentonite mixture. Drilling spoils and excess sample were placed in containers provided by Solutia along with drilling fluids displaced during grouting.

Field boring logs were prepared by a URS representative based upon recovered soil samples, cuttings, and drilling characteristics. The logs have been subsequently modified to reflect laboratory test results. Boring locations are shown in Figure 1 and a graphic subsurface profile is shown in Figure 2. Detailed boring logs are given in Appendix A.

LABORATORY TESTING

Laboratory tests were performed on selected samples from each episode of drilling. The types of tests performed are given in the following table. Test results are given in Appendix A.

Summary of Laboratory Tests Performed	
Test Name	ASTM Designation
Unit weight+ Water Cont.	D2937
Classification of Soil	D2487
Water Content	D2216
Liquid and Plastic Limit	D4318
Sieve +Hydrometer	D422
Percent Fines	D1140

Summary of Laboratory Tests Performed	
Consolidation	D2435
Unconfined Compression	D2166
Unconsolidated Undrained Triaxial	D2850
Specific Gravity	D854

SUBSURFACE PROFILE

The subsurface profile consists of four primary soil strata above limestone bedrock. These strata beginning from the ground surface and extending downward are as follows:

Summary of Key Soil Strata			
Strata Number	Depth below grade (ft)		Description
	From	To	
1	0	4	Firm low to medium plastic CLAY
2	4	20	Very loose to loose SILT and Sandy SILT
3	20	50	Loose to medium dense Silty SAND and SAND
4	50	100*	Dense to very dense SAND and Silty SAND with trace gravel.

*This stratum is assumed to extend to limestone bedrock at a depth of approximately 100 ft below the ground surface. (Figure 3).

A summary of soil properties for these key strata used for analysis is given in Table 1.

GROUNDWATER

In the 1999 explorations, the water surface was encountered between depths below grade of 9 and 15 ft in all borings at the time of drilling on November 8, 1999. In each of the 2000 borings, groundwater was first encountered at depths of about 15 ft below grade, but rose to between 7 and 8 feet (elevation 390 to 395) shortly after drilling. Groundwater elevations in the piezometer varied between El. 391.8 and 392.5 during November and December of 1999. A summary of groundwater elevations from the borings and piezometer are given in Table 2. Groundwater elevations likely fluctuate seasonally with the stage of the Mississippi River.

ENGINEERING ANALYSES AND RECOMMENDATIONS

The landfill cell will consist of exterior compacted fill dikes and will contain a liner system, waste material, and liner cap. Geotechnical analyses were performed to evaluate Foundation and Mass Stability according to IEPA requirements (Title 35 of the Illinois Administrative Code, Section 811.304). Analyses included:

- ❑ Static bearing capacity,
- ❑ Static stability of exterior slopes,
- ❑ Settlement of the landfill,
- ❑ Seismic evaluation including liquefaction triggering, seismically induced settlement, seismic bearing capacity and seismic slope stability. Results of these analyses are summarized in the following paragraphs.

Settlement Analyses

Analyses of the landfill were performed to estimate settlement at various locations in the landfill.

Soil properties assumed for design were determined from the consolidations tests (for the upper clayey and silty soils), and from Standard Penetration Test data for the underlying sands. For design purposes groundwater was assumed at grade. Analysis was performed using UniSettle software. Results are shown in Figure 5 which indicates a maximum total settlement of about 4 inches which occurs at the center of the landfill and a minimum of about 0.4 inches near the toe of the outboard berms. Because of the granular nature of the foundation soils, and over consolidation of the clay, we anticipate that most settlement will occur during fill placement. Settlement is estimated to be essentially complete within 60 days after completion of the cell.

Liquefaction induced settlement due to earthquake shaking will add to the static settlement as discussed in subsequent sections of this report.

Slope Stability Analyses

We evaluated the stability of the out-board 4H:1V slopes of the proposed landfill. This analysis was an undrained analysis performed using the slope-stability program Slope-W based on Spencer's Method of Analysis. Soil properties for the various strata were determined based upon laboratory test results, and Standard Penetration Test results. The compacted embankment properties were based upon local experience with similar type soils. Both circular and noncircular surfaces were searched for the minimum factor of safety. The highest proposed slope was analyzed, as it is the most critical case. Results of the analysis are plotted in Figure 5, which indicate a static factor of safety of 2.5, which exceeds the IEPA required value of 1.5.

The outboard slopes were also evaluated for the seismic case as noted in subsequent sections of this report.

Bearing Capacity

For a large flexible structure such as the proposed landfill with sloped beams at the perimeter, bearing capacity is an unlikely mode of failure. Rather, the controlling mode of foundation failure is the potential for slope instability of the outboard slopes. Slope stability analysis discussed above, indicates an acceptable factor of safety.

Seismic Evaluation

East St. Louis is an area of moderate seismicity. The estimated bedrock acceleration (PGA) based on 1996 USGS¹ maps is about 0.1g for a 10 percent probability of exceedance in 50 years. This value is very close to the design bedrock acceleration of 0.11g required by IDOT for design of structures. The corresponding earthquake magnitude is approximately (Ms) 6.5 based on USGS data. The soils above rock will tend to amplify the bedrock motion resulting in a higher acceleration near the ground surface. The surface acceleration was estimated based on NEHRP 1997² criteria, which indicate an amplification factor of about 1.6 for this soil profile. The design ground surface design acceleration is therefore 0.16g with a corresponding earthquake magnitude (Ms) of 6.5.

The two analyses performed included liquefaction triggering (to determine if accelerations were large enough to cause liquefaction) and pseudo-static slope stability analysis of the outboard slopes.

Liquefaction Triggering

The liquefaction potential of the site was evaluated using the "simplified procedure" by Seed and Idriss, (1972) as updated in NCEER, 1997³. Based on this analysis, the factor of safety against liquefaction triggering was calculated versus depth. Results are shown in Figure 6. Analysis shows that the Factor of Safety is typically much greater than 1.0 indicating that liquefaction is not likely to be triggered at the site. However, some settlement due to shaking is likely and estimated to be up to about 3 inches. This would be added to the static settlement noted above. The consequences of damage to the liner and the foundation are judged to be tolerable for this seismically induced settlement.

¹ United States Geologic Survey, National Seismic Hazard Mapping Project, 1996, URL: <http://geohazards.cr.usgs.gov/eq/>

² National Earthquake Hazard Reduction Program, Federal Emergency Management Agency (FEMA 303), NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, 1997.

³ Youd, T. Leslie and Idriss, Izzat M. (1997) "Proceeding of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils." Technical Report NCEER-97-0022, December 31. 1088-3800

Seismic Slope Stability

Pseudo-static slope-stability analysis was run assuming an acceleration of 0.16 g for the outboard slopes. Results are given in Figure 7, which indicate a factor of safety of 1.5, which is in excess of the IEPA required value of 1.3.

SUMMARY AND CONCLUSIONS

1. The site is underlain by a near-surface loose silt and firm clay layer that extends to a depth of approximately 20 ft below grade. This stratum is underlain to bedrock by sand that is typically medium dense near its surface and increases in density with depth, becoming dense to very dense. Limestone bedrock is estimated to be about 100 ft below surface grade.
2. Groundwater is present about 10 ft below grade, and varies in elevation seasonally with the stage of the Mississippi River.
3. The bedrock acceleration due to seismic shaking, based on a 500 year design period, is estimated by USGS to be 0.1 g with a resulting ground surface acceleration of approximately 0.16 g.
4. The potential for seismically induced liquefaction is judged to be small, however some seismically induced settlement, about 3 inches, is possible if the design ground motion occurs.
5. Static settlement of the landfill is estimated to be a maximum of approximately 4 inches at the center, and less than one inch near the toe of the perimeter berms. The estimated settlement is considered tolerable for the landfill.
6. Stability of the outboard slopes, for both static and seismic conditions meets or exceeds the IEPA requirements.
7. Due to its flexibility and shape (outboard slopes), bearing capacity failure of the landfill is not a likely mode of failure. A more probable mode of foundation failure would be slope stability, which has been shown to meet IEPA requirements.
8. The proposed landfill is judged to be acceptable and meet IEPA requirements for Foundation and Mass Stability.

LIMITATIONS

The boring logs and piezometer indicate conditions for the specific locations and dates. Non-uniform conditions, however, can exist between borings, which if encountered may require some field modifications to the landfill design. This contingency should be considered and a budget allowance established.

Table 1
Summary of Data for Key Strata

Solutia Inc. - Sauget Area 1
Cahokia, Illinois

Stratum	N (blows/ft)			w_{nat} (%)			LL (%)			PL (%)			γ_{tot} (pcf)			s_u (tsf)	P_c (tsf)	$C_c/(1+e_0)$	$C_r/(1+e_0)$	Minus	D_{10} (mm)	K (cm/sec)
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg					No. 200 (%)		
1	9	3	6	36	6	23	60	34	42	24	14	20	116	92	108	0.44	3	0.08	0.009	65-98	< 0.001	$10^{-6} - 10^{-7}$
2	10	0	5	37	6	26	38	32	35	25	19	22	115	89	107	0.25	3	0.10	0.012	18-99	< 0.001 - 0.02	$10^{-4} - 10^{-6}$
3	48	7	21	32	18	24	-	-	-	-	-	-	-	-	-	-	-	-	-	2-46	< 0.001 - 0.1	$10^{-3} - 10^{-4}$
4	79	37	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Description of Soil Strata:

1. Firm, moist, low to medium plastic, Silty CLAY (CL)
2. Very loose to loose, dry to wet, SILT to Sandy SILT (ML) with possibly some Clay lenses
3. Loose to medium dense, wet, Silty SAND to SAND (SM,SP)
4. Dense to very dense, wet, Silty SAND to SAND (SM, SP) with a trace of gravel

N - Number of blows per inch from standard penetration test

w_{nat} - Natural water content

LL - Liquid limit of material

PL - Plastic limit of material

γ_{tot} - Total unit weight of material

s_u - Undrained shear strength

P_c - Preconsolidation pressure

$C_c/(1+e_0)$ - Compression ratio, strain per log of stress beyond preconsolidation pressure

$C_r/(1+e_0)$ - Recompression ratio, strain per log of stress below preconsolidation pressure

No. 200 - Percentage passing the 200 sieve

D_{10} - Diameter at which 10% of the soil finer

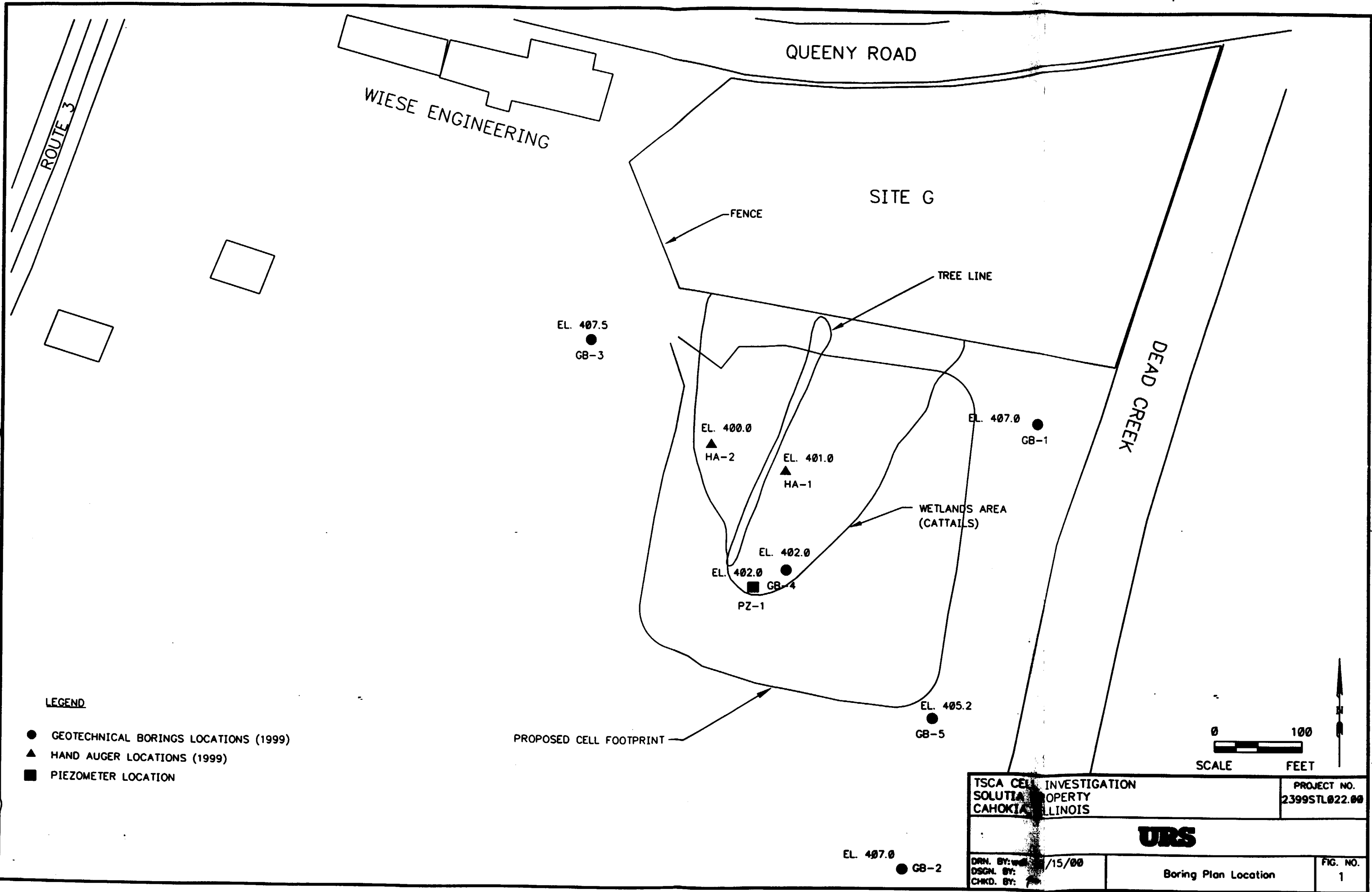
K - Coefficient of permeability from consolidation test or estimate from gradation

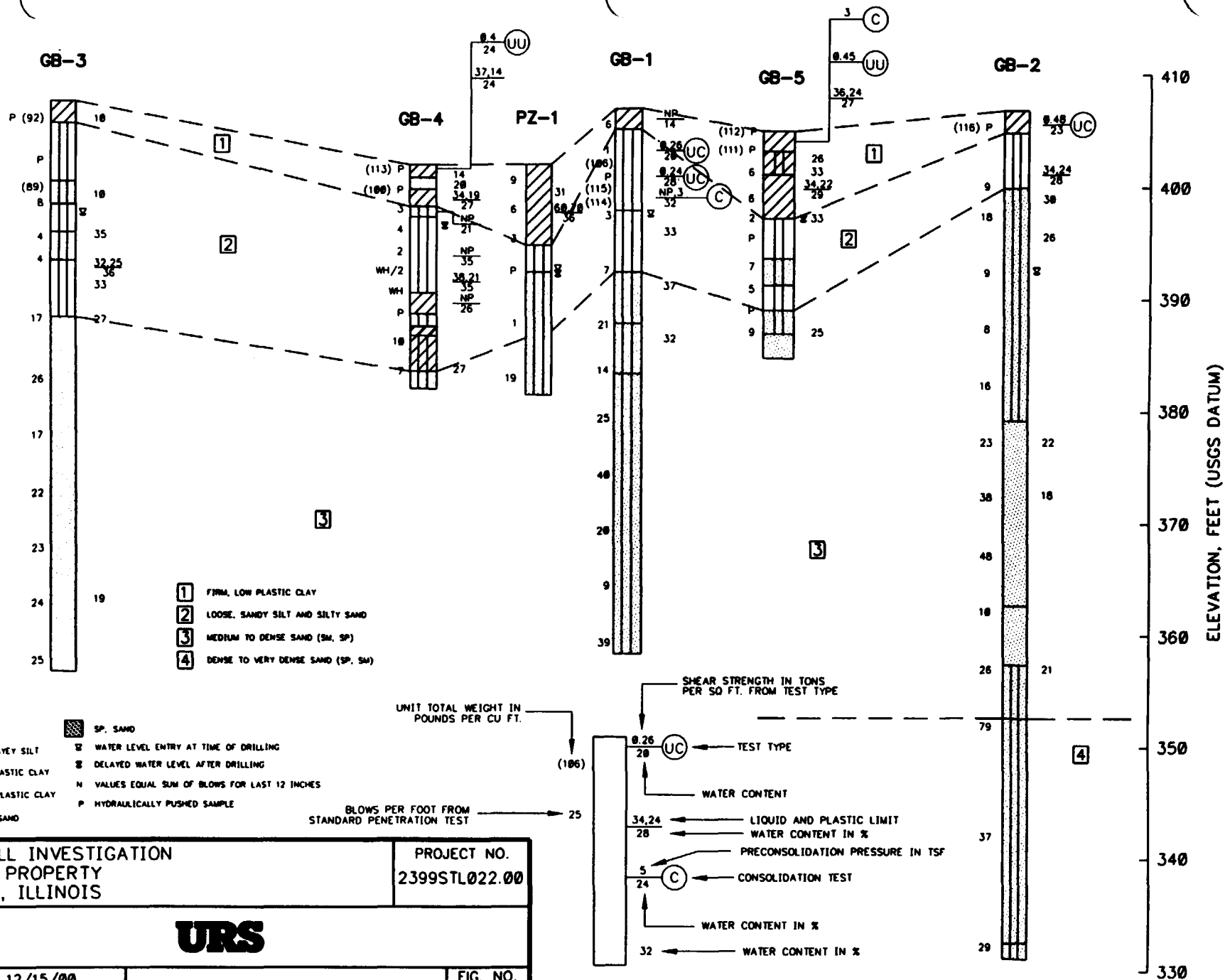
Table 2
Summary of Water Level Readings
Solutia Inc. TSCA Cell
Cahokia, IL

Date	Time (HRS)	GB-1 Elev. (FT)		GB-2 Elev. (FT)		GB-3 Elev. (FT)		GB-4 Elev. (FT)		GB-5 Elev. (FT)		PZ-1 Elev. (FT)	
		407		407		407.5		402		405.2		402	
		Depth (FT.)	Elevation (FT.)	Depth (FT.)	Elevation (FT.)	Depth (FT.)	Elevation (FT.)	Depth (FT.)	Elevation (FT.)	Depth (FT.)	Elevation (FT.)	Depth (FT.)	Elevation (FT.)
11/08/1999	ATD	10	397.0									9.5	392.5
	18 hrs. after drilling			14	393.0							10	392.0
11/09/1999	ATD												
11/10/1999	ATD					10.5	397.0						
11/15/1999												9.77	392.2
11/22/1999												9.95	392.1
12/01/1999												10.22	391.8
11/07/2000	ATD							15.5	386.5				
	3 hrs after drilling							7.1	394.9				
11/07/2000	ATD									15	390.2		
	1 hrs after drilling									8	397.2		

ATD - At time of drilling

File: S:\ADN\ADD\FIG1.DWG Last edited: 12/15/00 12:16 p.m. WC-ST.LOU MO





TSCA CELL INVESTIGATION
 SOLUTIA PROPERTY
 CAHOKIA, ILLINOIS

PROJECT NO.
 2399STL022.00

URS

Subsurface Profile

FIG. NO.
 2

DRN. BY: djd 12/15/00
 DSGN. BY: tlc
 CHKD. BY: [signature]

NOTES: THESE GRAPHIC LOGS DEPICT GENERALIZED SOIL CONDITIONS REFER TO INDIVIDUAL LOGS FOR DETAILS

ILLINOIS STATE GEOLOGICAL SURVEY

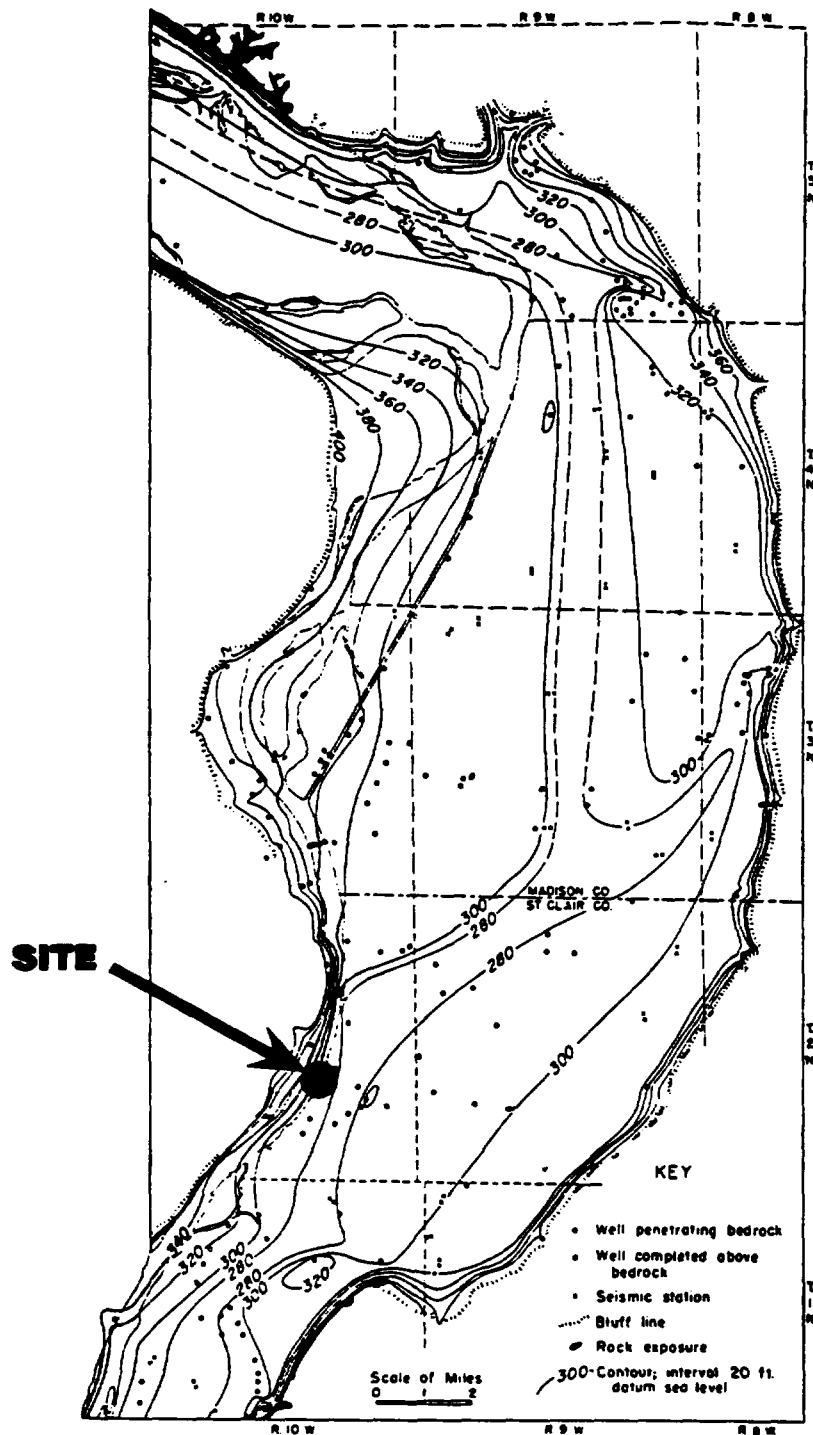


FIG. 2.—Bedrock surface map of the East St. Louis area, Ill.

Reference: Map taken from Groundwater Geology of the East St. Louis Area, Illinois, R. Bergstrom and T. Walker, 1956.

TSCA CELL INVESTIGATION
SOLUTIONIA PROPERTY
CAHOKIA, ILLINOIS

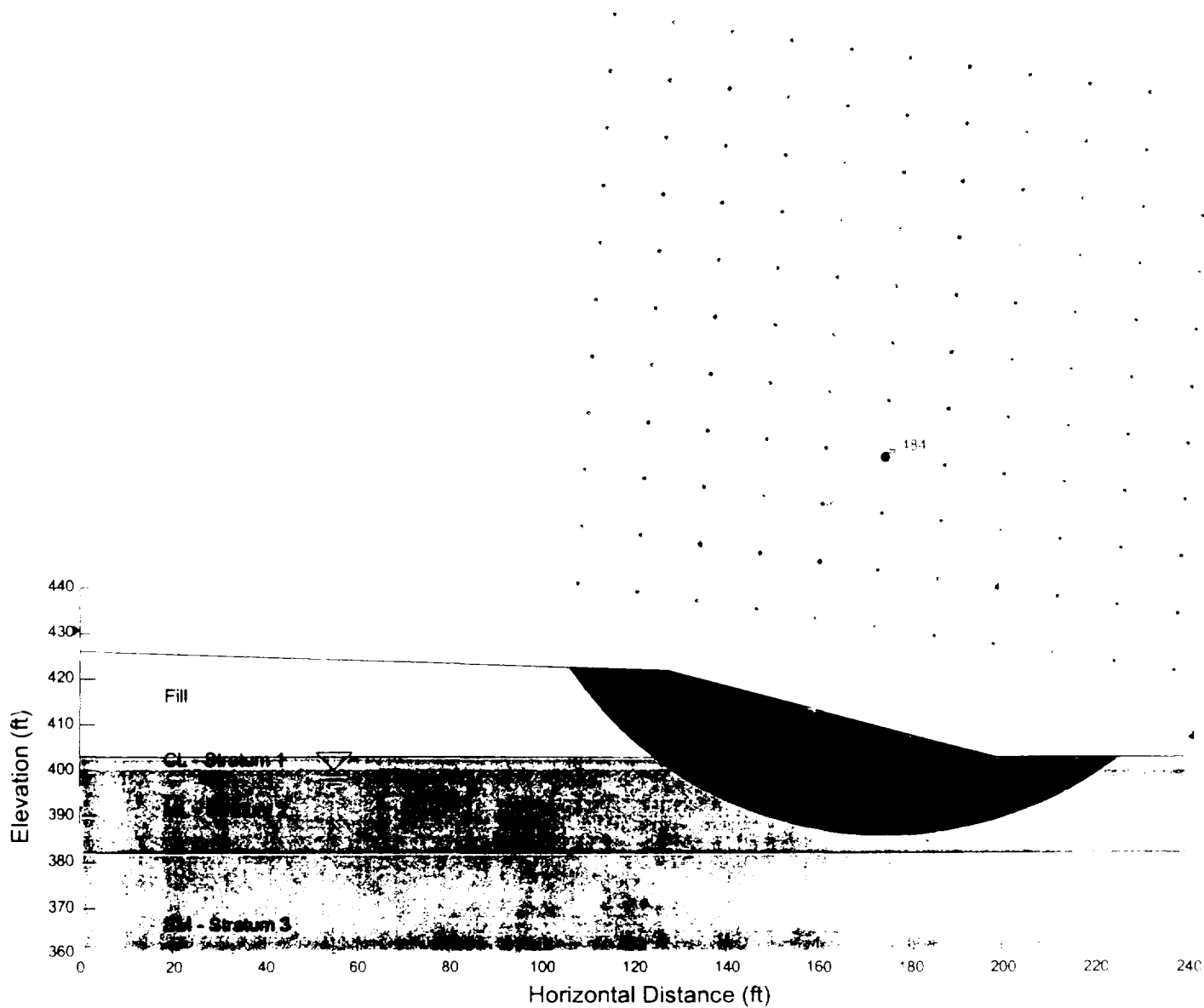
PROJECT NO.
2399STL022.00

URS

ORN. BY: wdl 12/15/00
DSGN. BY:
CHKD. BY: *z*

Bedrock Elevation Map

FIG. NO.
3



Fill
 Soil Model: Undrained ($\Phi=0$)
 Unit Weight: 125
 Cohesion: 2000
 Piezometric Line #: 1

ML - Stratum 2
 Soil Model: Undrained ($\Phi=0$)
 Unit Weight: 107
 Cohesion: 500
 Piezometric Line #: 1

CL - Stratum 1
 Soil Model: Undrained ($\Phi=0$)
 Unit Weight: 108
 Cohesion: 880
 Piezometric Line #: 1

SM - Stratum 3
 Soil Model: Mohr-Coulomb
 Unit Weight: 115
 Cohesion: 0
 Φ : 28
 Piezometric Line #: 1

Solutia Inc. Sauget Area 1 - Cahokia Illinois
 Undrained Analysis
 File Name: Slip stab - undrained slip
 Last Saved Date: 12/4/00
 Last Saved Time: 12:32:30 PM
 Analysis Method: Spencer
 Slip Surface Option: Grid and Radius
 P.W.P. Option: Piezometric Lines / Ru
 Tension Crack Option: (none)
 Seismic Coefficient: (none)

Project No.
 2399STL022.01

Solutia, Cahokia, IL.

Static Slope Stability Analysis Results,
 Outboard Slopes of TSCA Cell

FIGURE
 5

URS CORPORATION

Factor of Safety Against Liquefaction Triggering vs. Depth for Solutia, Inc. (TSCA Cell)

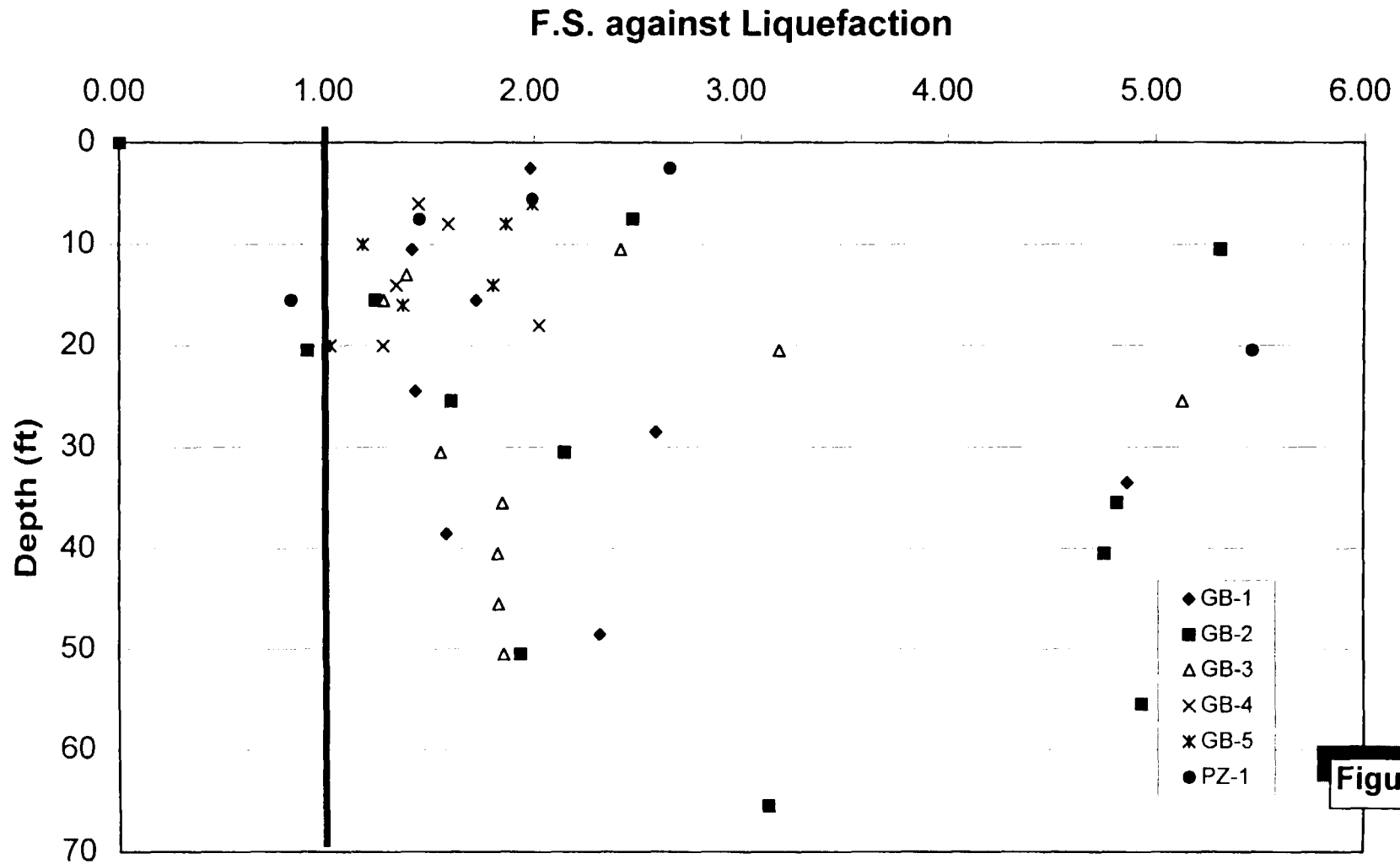
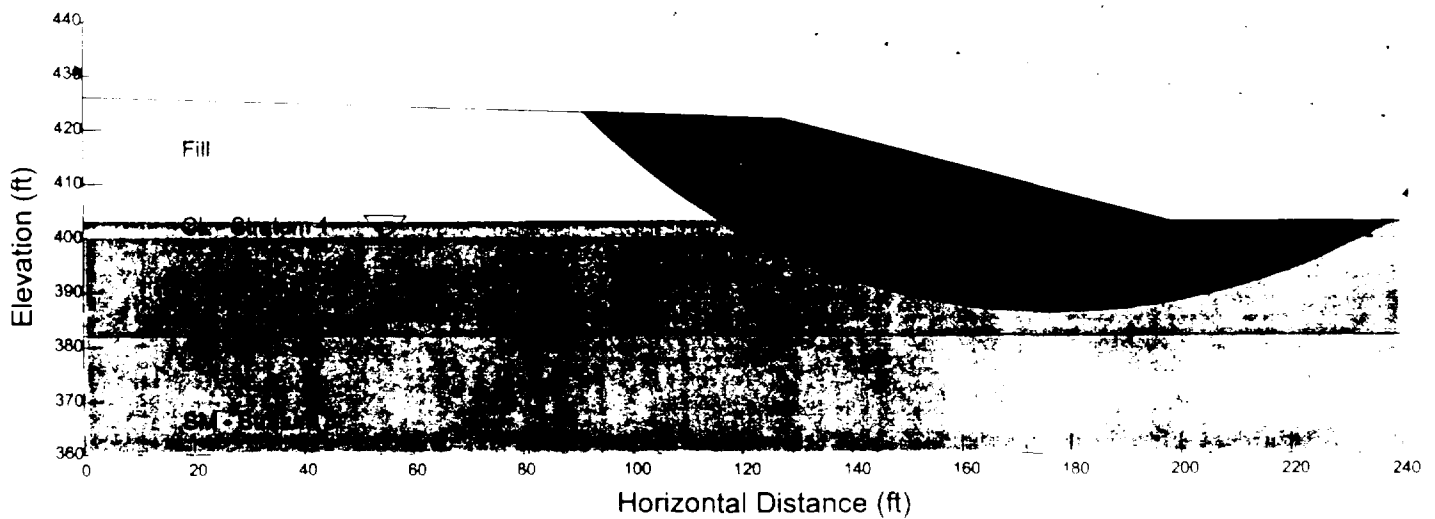


Figure 6



Fill
 Soil Model: Undrained (Phi=0)
 Unit Weight: 125
 Cohesion: 2000
 Piezometric Line # 1

CL - Stratum 1
 Soil Model: Undrained (Phi=0)
 Unit Weight: 108
 Cohesion: 880
 Piezometric Line #: 1

ML - Stratum 2
 Soil Model: Undrained (Phi=0)
 Unit Weight: 107
 Cohesion: 500
 Piezometric Line # 1

SM - Stratum 3
 Soil Model: Mohr-Coulomb
 Unit Weight: 115
 Cohesion: 0
 Phi: 28
 Piezometric Line #: 1

Solutia Inc. Sauget Area 1 - Cahokia, Illinois
 Undrained Analysis
 File Name: Slp stab - undrained - seismic 0 16g.slp
 Last Saved Date: 12/14/00
 Last Saved Time: 7:40:58 AM
 Analysis Method: Spencer
 Slip Surface Option: Gnd and Radius
 P.W.P. Option: Piezometric Lines / Ru
 Tension Crack Option: (none)
 Seismic Coefficient: Horizontal

Project No.
 2399STL022.01

Solutia, Cahokia, IL.

Seismic Slope Stability Analysis Results,
 Outboard Slopes of TSCA Cell

FIGURE
 7

URS CORPORATION

KEY TO BORING LOGS

Graphic Symbol	Description	USC Class.	TERMS DESCRIBING CONSISTENCY OR CONDITION		
GRAVEL	GRAVEL with little or no fines	GP or GW	Coarse grained soils (major portion retained on No. 200 sieve): Includes gravels and sands. Condition is rated according to the Standard Penetration Resistance, as shown below.		
	Silty GRAVEL	GM			
	Clayey GRAVEL	GC			
SAND	SAND with little or no fines	SP or SW	Fine grained soils (major portion passing No. 200 sieve): Includes clays and silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.		
	Silty SAND	SM			
	Clayey SAND	SC			
LOW PLASTIC SILTS AND CLAYS	Inorganic low plastic SILT	ML	Descriptive Term	Unconfined Compressive Strength, tons/sq. ft.	Blows per Foot
	Inorganic low plastic CLAY	CL	Very loose	less than 0.25	0 - 5
	Silty	CL	Loose	0.25 - 0.50	5 - 10
	Sandy	CL	Medium dense	0.50 - 1.00	10 - 30
	Gravelly	CL	Dense	1.00 - 2.00	30 - 50
	Organic low plastic SILT or CLAY	OL	Very dense	2.00 - 4.00	Greater than 50
HIGH PLASTIC SILTS AND CLAYS	Inorganic high plastic SILT	MH	LEGEND AND NOMENCLATURE Standard Penetration Sample Liner-tube sample, obtained by penetration of thick wall sampler containing 2 in. diameter liner-tubes (California sampler). Undisturbed sample, obtained by penetration of minimal 3 in. diameter, thin wall tube or, where indicated, fixed-piston sampling head. NX core.		
	Inorganic high plastic CLAY	CH			
	Organic high plastic SILT or CLAY	OH			
	Peat and other highly organic soils	PT			
ROCKS	LIMESTONE		PP,tsf	Unconfined compressive strength in tsf estimated with pocket penetrometer.	
	SHALE		TV,tsf	Undrained shear strength in tsf estimated with torvane.	
	SANDSTONE		NMC,%	Natural Moisture Content, %	
	SILTSTONE		LL	Liquid Limit	
			PI	Plasticity Index	
SURFACE MATERIALS	Topsoil or pavement		Qu, ksf	Unconfined Compressive Strength (Laboratory), ksf	
	FILL		RQD=80%	Percentage (80) of Rock Quality Designation	
				Depth Groundwater enters at time of drilling.	
				Groundwater Level at some specified time after drilling.	
			SAMPLING RESISTANCE		
			P	Sample pushed by hydraulic rig action.	
			3	Numbers indicate blows per 6 in. of sampler penetration when driven by a 140 lb hammer falling freely 30 in. The Standard Penetration	
			6	Resistance is the number of blows for the last 12 in. of penetration of the Standard Penetration sampler, e.g. 15.	
			9	Standard Penetration Resistance	
			15	Number of blows (50) used to drive the Standard Penetration Sampler a certain number of inches (2).	
			50/2		
			ABBREVIATIONS USED UNDER "FIELD NOTES"		
			HSA = Hollow Stem Auger		
			CFA = Continuous Flight Auger		
			ATD = At Time of Drilling		
			AD = After Drilling		
			DWL = Drill Water Loss		
			DWR = Drill Water Return		

Figure A-1

LOG of BORING No. GB-1											Sheet 1 of 2		
DATE 11/8/99		SURFACE ELEVATION, FT 407.0		DATUM USGS		LOCATION See Figure 1							
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0													
3	4	100		Firm, dark brown, moist, low plasticity Silty CLAY (CL)	405.2								Boring advanced with 4 1/4 in. I.D HSA and Mud rotary
3	3			Loose tan, dry, fine Sandy SILT (ML)	1.8				14				
5								0.5	20				
								0.5	19				
									18				
				Becoming moist					22				
									28				
									33				
									35				
10	2	100		Very loose, tan, wet, SILT (ML); with trace of clay and some fine sand	398.0				32				
	1				9.0								
	2								33				
				Becoming loose									
15	4												
	4												
	3			Loose, wet, tan, fine Silty SAND (SM)	14.5				37				
					392.5								
20	7	83		Medium dense, tan, wet fine Sandy SILT, to Silty SAND (SM/ML)	19.0								
	11				388.0								
	10								32				
	7	72		Medium dense, tan, wet, medium to fine Silty SAND (SM)	383.5								
	6				23.5								
	8												

Completion Depth: 48.5 Ft. Water Depth: 10 ft., After ATD hrs.

Project No.: 2399STL022 ft., After hrs.

Project Name: Solutia ft., After hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

12/2/99 WCCXS TL022

URS Greiner Woodward Clyde

5

Sheet 2 of 2

DATE _____

SURFACE ELEVATION, FT.

407.0

DATUM USGS

LOCATION See Figure 1

[illegible]

48.5 Ft.

Water Depth: 10

2399STL022

ft After _____ hrs.

aria

ft. After _____ hrs.

1

Lopped by:

Tim Hicks

12/2/99 WCCXS TLO22

URS Greiner Woodward Clyde

Figure A-2

LOG of BORING No. GB-2										Sheet 1 of 4			
DATE 11/9/99		SURFACE ELEVATION, FT 407.0		DATUM USGS		LOCATION See Figure 1							
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0				Brown, soft, moist, low plasticity Silty CLAY (CL)	405.0			1.0	22				Boring advanced with 4 1/4in. I.D HSA and Mud Rotary
			33	Loose, tan, dry, fine Sandy SILT (ML)	2.0			23	19				
5			58	Becoming Medium dense, gray with iron staining					28	34	10		
5			49		400.0								
10			89	Loose, moist, gray, fine Silty SAND (SM)	7.0				30				
10			5	Becoming medium dense, light brown and gray					26				
15			67	Becoming loose and saturated									Switched to Mud Rotary
20			78	Trace of fine gravel, becoming coarse to fine sand									
4			67	Becoming medium dense with a trace of medium to fine gravel									

Completion Depth: 75.5 Ft.	Water Depth: 14	ft., After	ATD	hrs.
Project No.: 2399STL022		ft., After		hrs.
Project Name: Solutia		ft., After		hrs.
Drilling Contractor: Redi	Logged by: Tim Hicks			

12/2/99 WCCXS TL022

Figure A-2

LOG of BORING No. GB-2										Sheet 2 of 4			
DATE <u>11/9/99</u>		SURFACE ELEVATION, FT <u>407.0</u>		DATUM <u>USGS</u>		LOCATION <u>See Figure 1</u>							
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
25	6	10		Medium dense, gray, wet Silty SAND (SM); with a trace medium to fine gravel									
30	5	10		Medium dense, gray, wet Silty SAND (SM)					22				
35	15	19	67	Becoming dense									
40	9	20	78	With fine gravel, decrease in silt content									
	28												
45	5	6	78	Loose, medium dense, moist, gray coarse to fine SAND (SP); with some fine gravel	363.0								
	4				44.0								
	6		78		357.7								
					49.3								

Completion Depth: <u>75.5 Ft.</u>	Water Depth: <u>14</u> ft., After <u>ATD</u> hrs.
Project No.: <u>2399STL022</u>	ft., After _____ hrs.
Project Name: <u>Solutia</u>	ft., After _____ hrs.
Drilling Contractor: <u>Redi</u>	Logged by: <u>Tim Hicks</u>

Figure A-2

LOG of BORING No. GB-2												Sheet 3 of 4			
DATE		11/9/99		SURFACE ELEVATION, FT		407.0		DATUM		USGS		LOCATION		See Figure 1	
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES		
50	13	13		Medium dense, gray, moist, medium to fine SAND (SM/SP); with trace of silt					21						
55	30	39	100	Very dense, gray, moist, fine Silty SAND (SM)	353.0										
60				Very dense, gray, moist fine Silty SAND (SM)											
65	20	18	83	Becoming dense with some silt, coarse to fine sand, trace of fine gravel											
70															
	16	83			333.0										
					74.0										

Completion Depth:	75.5 Ft.	Water Depth:	14	f., After	ATD	hrs.
Project No.:	2399STL022			f., After		hrs.
Project Name:	Solutia			f., After		hrs.
Drilling Contractor:	Redi	Logged by:		Tim Hicks		

12/2/99 WCCXS TL022

URS Greiner Woodward Clyde

Figure A-2

LOG of BORING No. GB-2

Sheet 4 of 4

[illegible]

Figure A-3

LOG of BORING No. GB-3

Sheet 1 of 3

DATE 11/10/99 SURFACE ELEVATION, FT. 407.5 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LI	PI	Qu, KSF	NOTES
0													
			83	Medium stiff, dark brown, moist, low plasticity Silty CLAY (CL)	405.5				14				Boring advanced with 4 1/4 in. I.D HSA and Mud Rotary
				Loose, tan, dry SILT (ML); with some sand and trace of clay	2.0				6				
			63						9				
5			83	Loose, tan, dry fine SAND (SM); with some silt	7.0				7				
					400.5				6				
			94	Loose, brown, moist, fine Sandy SILT (ML/SM)	398.5				21				
10				Becoming saturated	9.0				8				
			83	Loose, gray, wet SILT (ML); with some sand	396.0				35				
					11.5								
			2		393.5				36				Switched to Mud Rotary
			1		14.0				32				
15			83	Loose, brown, tan, wet Sandy SILT (ML)					33				
			7		388.5								
			8	Medium dense, tan, gray, fine Silty SAND (SM)	19.0								
20			9						27				
			8										
			83										

Completion Depth: 50.5 Ft.Water Depth: 10.5 ft., After ATD hrs.Project No.: 2399STL022

ft., After _____ hrs.

Project Name: Solutia

ft., After _____ hrs.

Drilling Contractor: _____

Redi _____

Logged by: _____

Tim Hicks _____

12/2/99 WCCAS 11022

URS Greiner Woodward Clyde

LOG of BORING No. GB-3

DATE 11/10/99 SURFACE ELEVATION, FT 407.5 DATUM USGS LOCATION See Figure 1

Completion Depth: 50.5 Ft. Water Depth: 10.5 ft., After ATD hrs.
Project No.: 2399STL022 ft., After _____ hrs.
Project Name: Solutia ft., After _____ hrs.
Drilling Contractor: Redi Logged by: Tim Hicks

Figure A-3

LOG of BORING No. GB-3

Sheet 3 of 3

DATE 11/10/99 SURFACE ELEVATION, FT 407.5 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
50	11				357.0								
	14			Bottom of boring at 50.5 ft.	50.5								
55													
60													
65													
70													

Completion Depth: 50.5 Ft. Water Depth: 10.5 ft., After ATD hrs.

Project No.: 2399STL022 f., After _____ hrs.

Project Name: Solutia f., After _____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

Figure A-4

LOG of BORING No. HA-1

Sheet 1 of 1

DATE 11/15/99 SURFACE ELEVATION, FT 401.0 DATUM USGS LOCATION See Figure 1.

DEPTH, ft.	
SAMPLES	
SAMPLING RESISTANCE	
RECOVERY, %	
DESCRIPTION	
Firm, dark brown, low to medium Silty CLAY (CL)	
Loose, tan, fine Sandy SILT (SM); with trace of clay M/L	
Bottom of Hand Auger at 2ft.	
399.5	1.5
	399.0
	2.0
STRATUM EL / DEPTH	
SYMBOL	
PP, TSF	
FIELD Qu, KSF	
NMC, %	
LL	
PI	
Qu, KSF	
NOTES	

Completion Depth: 2.0 Ft.

Water Depth: _____ ft., After _____ hrs.

Project No.: 2399STL022

ft. After _____ hrs.

Project Name: Solutia

p. After _____ hrs.




Drilling Contractor: _____

Logged by: Tim Hicks

11/19/99 WCCXS TL022

URS Greiner Woodward Clyde

Figure A-5

LOG of BORING No. HA-2										Sheet 1 of 1			
DATE 11/15/99		SURFACE ELEVATION, FT 400.0		DATUM USGS		LOCATION See Figure 1.							
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0				Firm, dark brown, low to medium plasticity Silty CLAY (CL)	398.5								
				Loose, tan, fine Sandy SILT (SM); with trace of clay	1.5 398.0								
				Bottom of Hand Auger at 2ft.	2.0								
5													

Completion Depth: 2.0 Ft.	Water Depth: _____	f., After _____	hrs.
Project No.: 2399STL022		f., After _____	hrs.
Project Name: Solatia		f., After _____	hrs.
Drilling Contractor: Redi _____	Logged by: Tim Hicks _____		

11/19/99 WCCXS TL022

URS Greiner Woodward Clyde

Figure A-6

LOG of BORING No. GB-4

Sheet 1 of 1

DATE	11/7/00	SURFACE ELEVATION, FT	402.0	DATUM	USGS	LOCATION							
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0	P	96		Soft, moist, low plasticity Silty CLAY (CL)	400.7				24	37	14		Boring advanced with 4 1/4 in. I.D. 9 in. O.D HSA
				Very loose, moist, light brown to gray, fine SAND (SP)	1.3				14				
	P	86		Firm, moist, dark brown Silty CLAY (CL)	399.6				11				
					2.4				30				
	3	92		Very loose, moist, light brown to gray, Silty SAND (SM)	398.0				27	34	17		
					4.0								
				Loose, moist, brownish gray, Sandy SILT (ML)	397.0				21				
	4	83		Becomes very loose, wet, light brown	5.0								
	2	88											
				Becomes gray					35				
	10	WH/2	83										
				Very soft, wet, gray, low plastic Silty CLAY (CL)	390.0								
	WH				12.0								
				Loose, wet, gray SILT (ML)	388.1				35	38	21		
	P	67		Firm, gray, high plastic CLAY (CH)	387.2								
				Medium dense, wet, gray, SILT (CL-ML); trace sand	14.8				26				Clay lens, 10 in. thick
	10	75			386.5								
					15.5								
	7	67		Loose, wet, gray, Silty SAND (SM)	383.5								
					18.5								
				Bottom of boring at 20 ft.	382.0				27				
					20.0								

Completion Depth: 20.0 Ft.

Water Depth: 15.5 ft. After ATD hrs.

Project No.: 2399STL022

7.1 ft. After 3 hrs.

Project Name: Solutia

ft. After hrs.

Drilling Contractor:

Harriss Drilling

Logged by:

Martin Swanson

12/15/00 WCCXS TL022

URS Corporation

Figure A-7

LOG of BORING No. GB-5

Sheet 1 of 1

DATE	11/7/00	SURFACE ELEVATION, FT	405.2	DATUM	USGS	LOCATION							
DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu, KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0	P	71		Firm, lightly moist, brownish gray, Silty CLAY (CL)					25				Boring advanced with 4 1/4 in. I.D. 9 in O.D HSA
					403.2				26				
	P	54		Loose, moist, tan SILT (CL-ML); trace sand	2.0				27				
									28	34	12		
					401.2				31				
									26				
									22				
	6	92		Firm, moist, brown, low plastic CLAY (CL)	4.0				29	34	15		
	2	88		Very loose, wet, brown, Sandy SILT (ML)	397.2								
					8.0				33				No recovery
	P	0											
					393.2								
	7	75		Loose, wet, brown, Silty SAND (SM)	12.0								
					391.2								
	5	88		Loose, wet, brown, Sandy SILT (ML)	14.0								
	P	92		Loose, wet, brown, Silty SAND (SM)	389.2								
					16.0								
					387.2								
	9	100		Loose, wet, brown, fine SAND (SP)	18.0								
					385.2								
				Bottom of boring at 20ft.	20.0								
									25				

Completion Depth: 20.0 Ft.

Water Depth: 15 ft., After 15 hrs.

Project No.: 2399STL022

8 ft., After 1 hrs.

Project Name: Solutia

ft., After hrs.

Drilling Contractor: Harris Drilling

Logged by: Martin Swanson

12/15/00 WCCXS TL022

URS Corporation

LOG of BORING No. PZ-1

DATE 11/8/99 SURFACE ELEVATION, FT 402.0 DATUM USGS LOCATION See Figure 1

Completion Depth: <u>20.5 Ft.</u>	Water Depth: <u>9.5</u> ft., After <u>ATD</u> hrs.
Project No.: <u>2399STL022</u>	<u>10</u> ft., After <u>18</u> hrs.
Project Name: <u>Solutia</u>	<u> </u> ft., After <u> </u> hrs.
Drilling Contractor: <u>Redi</u>	Logged by: <u>Tim Hicks</u>

MONITORING WELL INSTALLATION REPORT

Project Solutia Well No. PZ-1
 Location See Figure 1.
 Project No 2399STL022 Installed By Redi Date 11/8/99 Time 1100
 Method of Installation 4 1/4 in. H.S.A. Done 1150

LOG OF BORING AND WELL

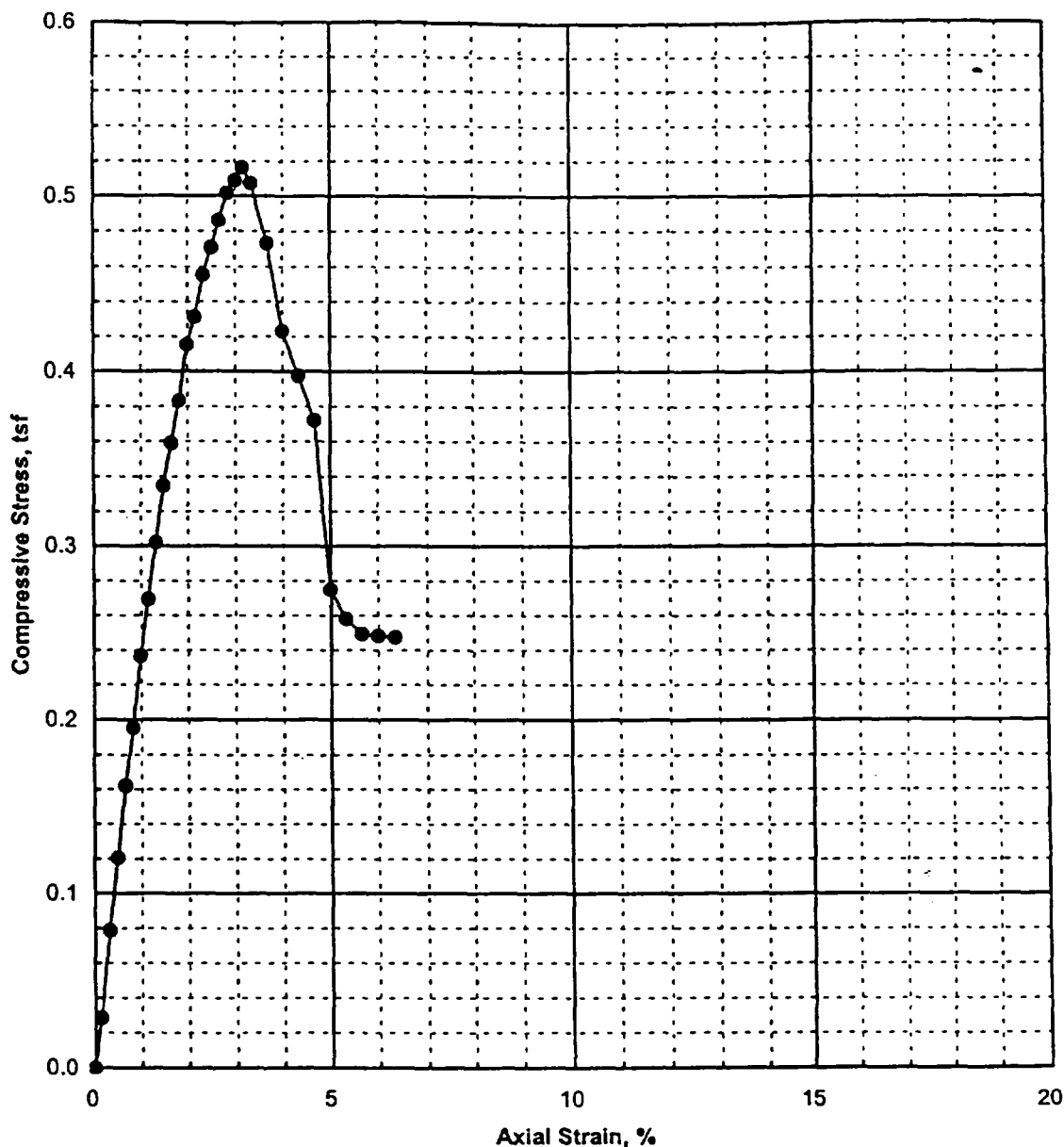
BORING			WELL	
Depth In Ft.	Description	Symbol	Type of Well	
0.00	Soft, moist, brown, low plasticity Silty CLAY Becoming stiff Becoming firm, medium plasticity mottled brown, gray		Ground Elev. <u>401.8</u>	Top of Riser Elev. <u>405.8</u>
7.20	Very loose, wet, gray, Sandy SILT (ML); with medium to fine sand			
9.50	Loose, wet, gray, medium to fine SAND (SM); with some silt			
	Very loose, wet, tan, fine SAND (SM); with a trace of silt			
	Becoming medium dense			
	Bottom of boring at 20.5ft.		L1 = <u>4.0</u> L2 = <u>1.0</u> L3 = <u>8.0</u> L4 = <u>11.0</u> L5 = <u>13.0</u> L6 = <u>10.0</u> L7 = <u>19.0</u>	Riser Pipe I.D., in. <u>1in.</u> Type of Pipe <u>PVC</u> Backfill Type Around Riser <u>Portland cement</u> Top of Seal Elevation _____ Type of Seal Material <u>See below</u> Top of Filter Elevation <u>8.0</u> Type of Filter Material <u>Quartz</u> Size of Opening, in. <u>0.01</u> Diameter of Well Tip, in. <u>1.0</u> Bottom of Screen Elevation <u>19.0</u> Bottom of Riser Elevation <u>19.0</u> Btm of Boring Elev. <u>19.0</u> Diameter of Boring, in. <u>4.2</u>

Remarks _____

Inspected By Tim Hicks

WOODWARD-CLYDE CONSULTANTS

Figure A-10



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
20.4	106.3	88.4			2.959	1.886

Description and/or Classification: ML, brown slightly to nonplastic SILT, trace f. sand

Test Summary

Tested by: BB
Test Date: Nov-18-99

Reviewed by: *mm*

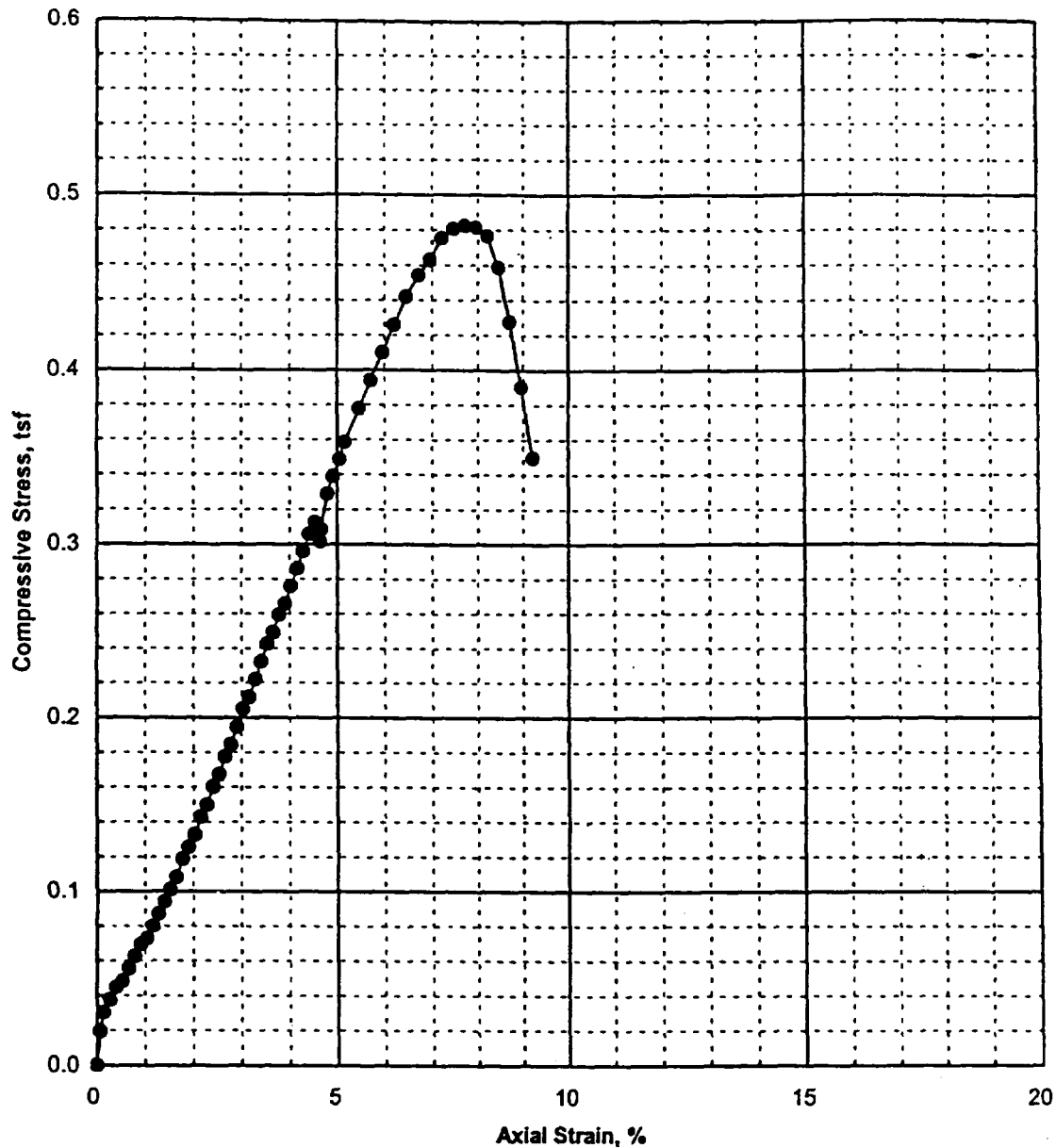
q_u (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.52	3.16	1.00



FAILURE SKETCH

Project No. 23-99STL0022.01	SOLUTIA	UNCONFINED COMPRESSION TEST Boring: GB-1	November 1999
URS Greiner Woodward Clyde		Sample: A Depth: 4.35-4.7	

Figure A-11



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
28.2	115.0	89.7			5.862	2.874

Description and/or Classification: ML, brown slightly to nonplastic SILT, trace f. sand

Test Summary

q_u (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.48	7.70	0.74

Tested by: BB

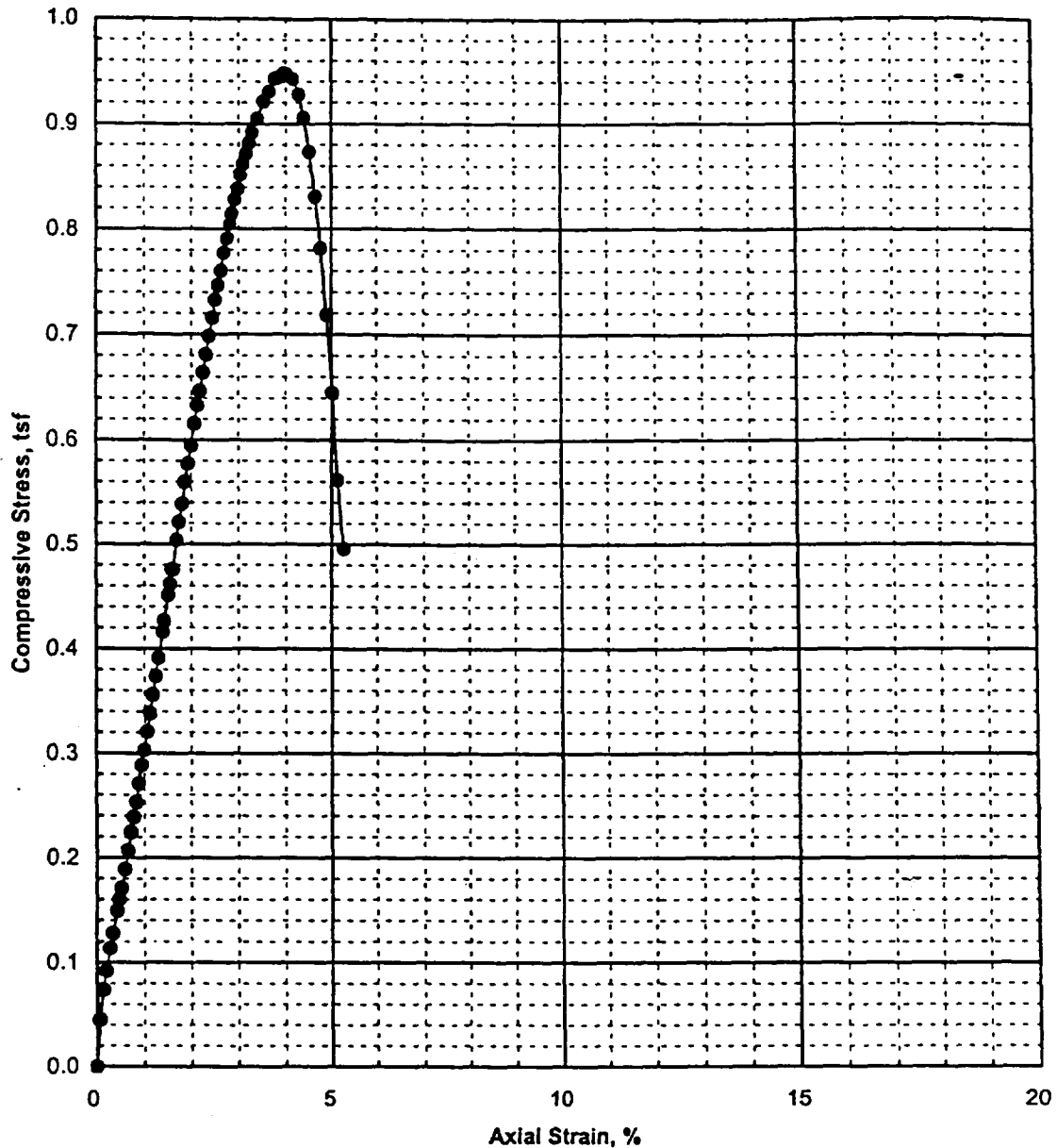
Test Date: Nov-17-99

Reviewed by: *97*

FAILURE
SKETCH

Project No. 23-99STL0022.01	SOLUTIA	UNCONFINED COMPRESSION TEST Boring: GB-1	
URS Greiner Woodward Clyde		Sample: A Depth: 6.45	November 1999

Figure A-12



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
22.6	116.0	94.7			6.006	2.873

Description and/or Classification: ML, light brown s-np SILT, trace clay; top 1" CL, dark brown silty CLAY.

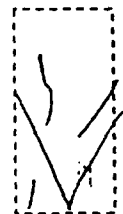
Test Summary

q_u (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.95	3.96	0.73

Tested by: BB

Test Date: Nov-29-99

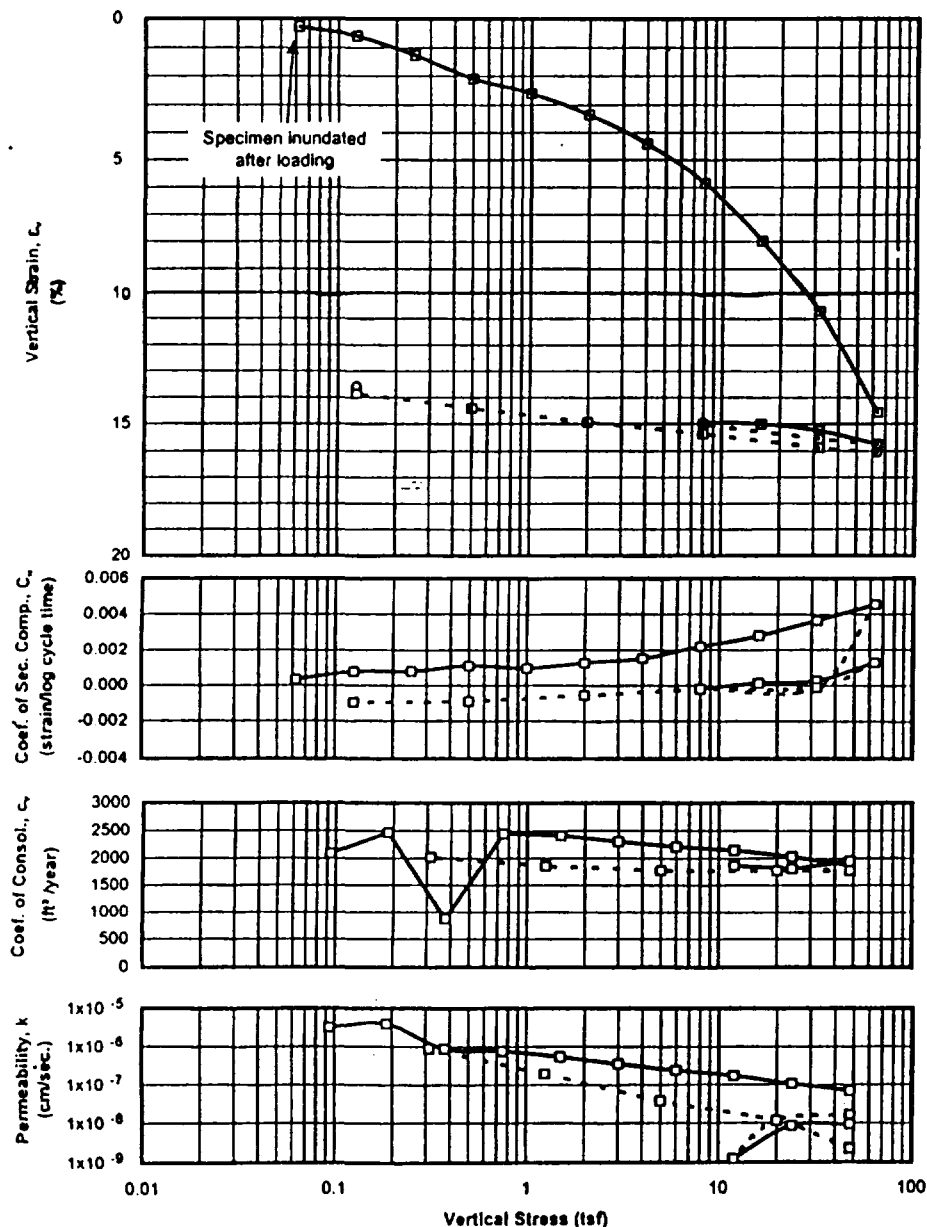
Reviewed by: 91



FAILURE SKETCH

Project No. 23-99STL0022.01	SOLUTIA	UNCONFINED COMPRESSION TEST Boring: GB-2	
URS Greiner Woodward Clyde		Sample: A Depth: 1.35	November 1999

Figure A-1



SAMPLE INFORMATION

Boring: GB-1
 Sample: Spec C
 Depth: 7.55 feet
 Elevation:
 Type: 3-inch thin wall tube
 ML, brown nonplastic SILT, trace f. sand

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height: 0.61 Inch
 Diameter: 2.50 Inch

Initial water content: 32.3 %
 Initial total unit weight: 113.9 pcf
 Initial dry unit weight: 86.1 pcf
 Initial void ratio: 1.000
 Initial degree of saturation: 89 %

Final water content: 29.6 %
 Final total unit weight: 122.9 pcf
 Final dry unit weight: 94.8 pcf
 Final void ratio: 0.818
 Final degree of saturation: 100 % (assumed specific gravity = 2.76)

TEST SUMMARY

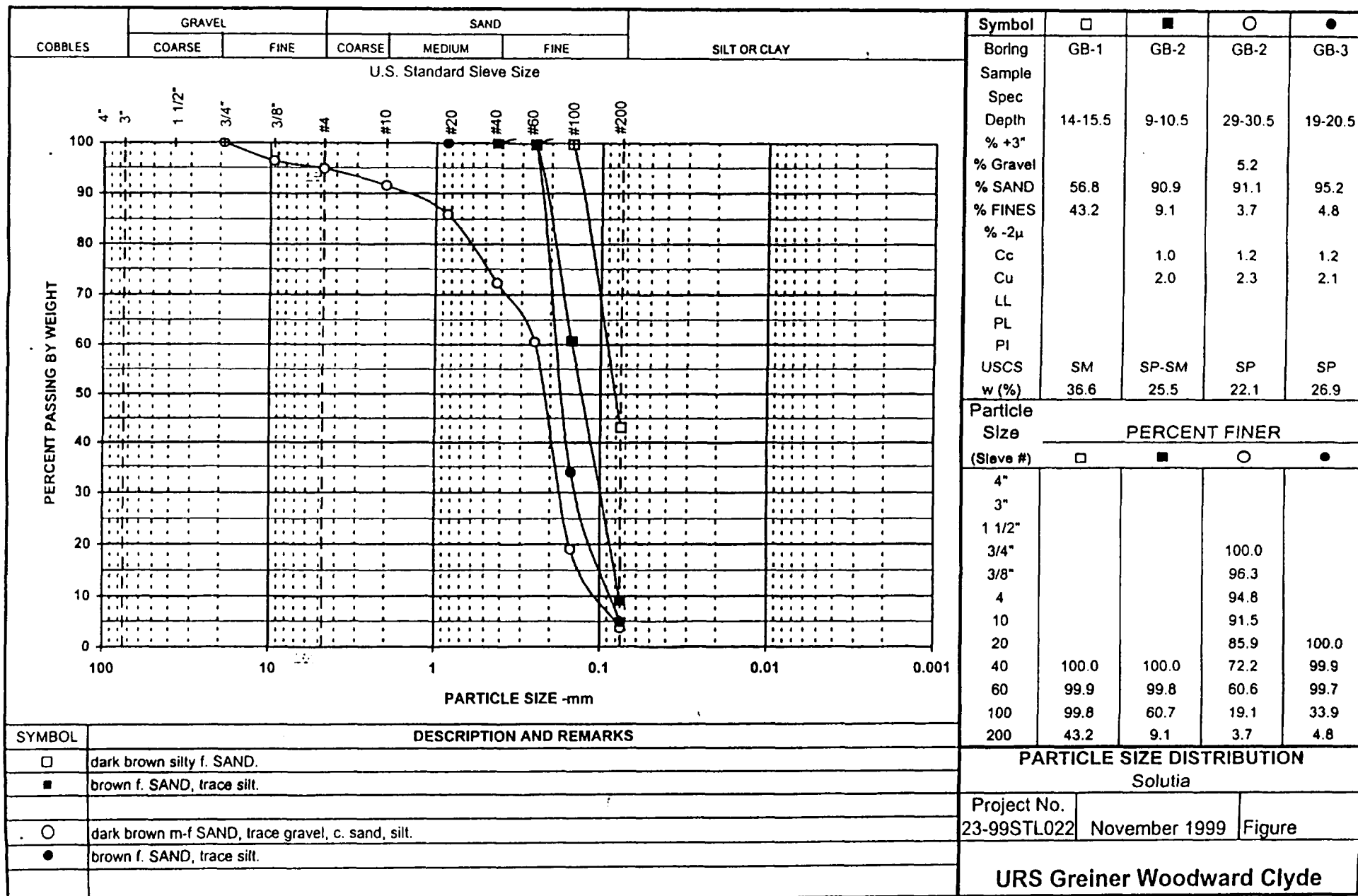
Construction Method: Casagrande (Log)
 Estimated preconsolidation stress (tsf): 12.8 (Range: 10.9 to 15.3)
 Estimated in situ effective overburden stress (tsf):
 Compression Ratio (strain per log cycle stress): 0.128
 Compression Index (void ratio per log cycle stress): 0.256
 Swell Ratio (strain per log cycle stress): 0.008
 Swell Index (void ratio per log cycle stress): 0.016
 Recompression Ratio (strain per log cycle stress): 0.012
 Recompression Index (void ratio per log cycle stress): 0.024
 Remarks:

LEGEND: □ End of primary ○ End of Stage — Loading - - - Unloading

Test Date: 11/17/99 Tested By: GET Checked By: 91

	Solutia	ONE DIMENSIONAL CONSOLIDATION TEST Boring: GB-1 Depth: 7.55 feet
URS Greiner Woodward Clyde	Project No. 23-99STL0022	November 1999 Fig.

Figure A-



PROJEC	Solutia				
PROJECT NO.:	23-99STL0022	Initial height:	0.613 inch	Final height:	0.554 inch
BORING:	GB-1	Initial water content:	32.3 %	Final water content:	29.6 %
SAMPLE:	Spec C	Initial dry density:	86.1 pcf	Final dry density:	94.8 pcf
TEST:	C99216	Initial total density:	113.9 pcf	Final total density:	122.9 pcf
DEPTH, feet:	7.55	Initial saturation:	89 %	Final saturation:	100 %
BY:	GET	Initial void ratio:	1.000	Final void ratio:	0.818
TEST DATE:	11/17/1999			Final strain:	9.8 %

EQUIPMENT:

Load Frame No.:

5

Ring Diameter:

2.5 inch

SPECIMEN DESCRIPTION: ML, brown nonplastic SILT, trace f. sand

Ring Diameter:		2.5 inch		G		LL		PL		PI	
				2.76				np			
Load	Load	d ₁₀₀	t ₁₀₀	t ₁₀₀	Final	Final	c _v	C _a	Constrained	Permeability	
No.	(tsf)	(inch)	Strain (%)	Void Ratio (-)	Strain (%)	Void Ratio (-)	(ft²/year)	(strain/logt)	Modulus (tsf)	(cm/sec)	
1	0.063	0.0017	0.277	0.995	0.345	0.994	89.22	0.0003	22.56	1.19E-07	
2	0.125	0.0037	0.602	0.988	0.857	0.983	2086.38	0.0007	19.26	3.27E-06	
3	0.250	0.0078	1.273	0.975	1.511	0.970	2467.32	0.0008	18.63	4.00E-06	
4	0.500	0.0128	2.093	0.959	2.371	0.953	871.77	0.0011	30.47	8.63E-07	
5	1.00	0.0160	2.610	0.948	2.905	0.942	2440.00	0.0009	96.78	7.61E-07	
6	2.00	0.0206	3.359	0.933	3.832	0.924	2407.63	0.0012	133.40	5.44E-07	
7	4.00	0.0271	4.410	0.912	4.911	0.902	2301.41	0.0015	190.31	3.65E-07	
8	8.00	0.0360	5.862	0.883	6.533	0.870	2207.57	0.0022	275.50	2.42E-07	
9	16.0	0.0490	7.994	0.841	9.213	0.816	2144.66	0.0028	375.26	1.72E-07	
10	32.0	0.0657	10.708	0.786	11.603	0.768	2031.05	0.0036	589.49	1.04E-07	
11	64.0	0.0893	14.564	0.709	15.759	0.685	1871.59	0.0046	829.93	6.80E-08	
12	32.0	0.0955	15.562	0.689	15.531	0.690	1796.95	-0.0001	3208	1.69E-08	
13	8.00	0.0922	15.023	0.700	14.940	0.702	1771.15	-0.0002	4455	1.20E-08	
14	16.0	0.0920	15.005	0.700	15.050	0.699	1868.95	0.0001	45734	1.23E-09	
15	32.0	0.0936	15.254	0.695	15.314	0.694	1809.76	0.0002	6429	8.49E-09	
16	64.0	0.0966	15.751	0.685	16.073	0.679	1950.94	0.0013	6443	9.14E-09	
17	32.0	0.0974	15.884	0.683	15.856	0.683	1778.30	-0.0001	24135	2.22E-09	
18	8.00	0.0943	15.367	0.693	15.306	0.694	1775.23	-0.0002	4647	1.15E-08	
19	2.00	0.0916	14.938	0.702	14.766	0.705	1778.33	-0.0006	1400	3.83E-08	
20	0.500	0.0884	14.412	0.712	14.070	0.719	1855.80	-0.0009	285.14	1.96E-07	
21	0.125	0.0850	13.863	0.723	13.580	0.729	2015.63	-0.0009	68.20	8.92E-07	

Solutia, Inc.
LABORATORY TESTING DATA SUMMARY

Fig A-16

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS									STRENGTH			CONSOL.		REMARKS
			WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	UU CELL PRESSURE (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	INITIAL CONDITIONS		
GB-4	S-1	0-2								101.8							
GB-4	S-1A	0.5	23.6	37	14	23	CL	65.3	21	113.1	2.654	0.5	0.8	15.6			
GB-4	S-1	1.2	14.4				SM										
GB-4	S-1C	1.55	14.1				SP			100.3						perm.	
GB-4	S-2	2-4								104.1							
GB-4	S-2	2.45	10.7				CL										
GB-4	S-2	3	30.4				CL										
GB-4	S-2B	3.25	26.9	34	19	15	CL	84.7	17								
GB-4	S-3	4-6	21.3	np	np	np	ML	58.9	5								
GB-4	S-4	6-8					ML									visual	
GB-4	S-5	8-10	34.6	np	np	np	ML	72.0	5		2.660						
GB-4	S-6	10-12					ML									visual	
GB-4	S-7	12-14	35.3	38	21	17	CL	99.4	16								
GB-4	S-8	14-16	25.8	np	np	np	ML	96.1	10								
GB-4	S-9	16-18					CL-ML	92.9	16								
GB-4	S-10	18-20	27.1				SM	18.6			2.672						

LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS									STRENGTH			CONSOL.		REMARKS
			WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	UU CELL PRESSURE (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	INITIAL CONDITIONS		
															VOID RATIO	SATUR- ATION	
GB-5	S-1	0-2								112.1							
GB-5	S-1	0.15	25.1														
GB-5	S-1A	0.4	26.4				CL	90.1	21	112.3		1.0	0.9	15.5			
GB-5	S-1	0.7	27.4				CL										
GB-5	S-1B	0.95	28.1	36	24	12	CL			114.2	2.670				0.856	87	
GB-5	S-2	2-4								111.1							
GB-5	S-2	2.15	30.7				CL-ML										
GB-5	S-2A	2.45	25.5				CL-ML	95.1									
GB-5	S-2	2.65	22.1				CL-ML										
GB-5	S-3	4-6	29.1	34	22	12	CL	98.0	13								
GB-5	S-4	6-8	29.4														
GB-5	S-5	8-10	33.1				ML	55.2									
GB-5	S-6	10-12															no sample
GB-5	S-7	12-14					SM	42.6	5								
GB-5	S-8	14-16					ML										visual
GB-5	S-9	16-18					SM	46.5	4								
GB-5	S-10	18-20	25.3				SP	3.3									

Note: (1) Plasticity of fines for USCS symbol based on visual observation unless Sieve and Atterberg limits reported.

VISUAL CLASSIFICATION

[illegible]

Figure A-1r

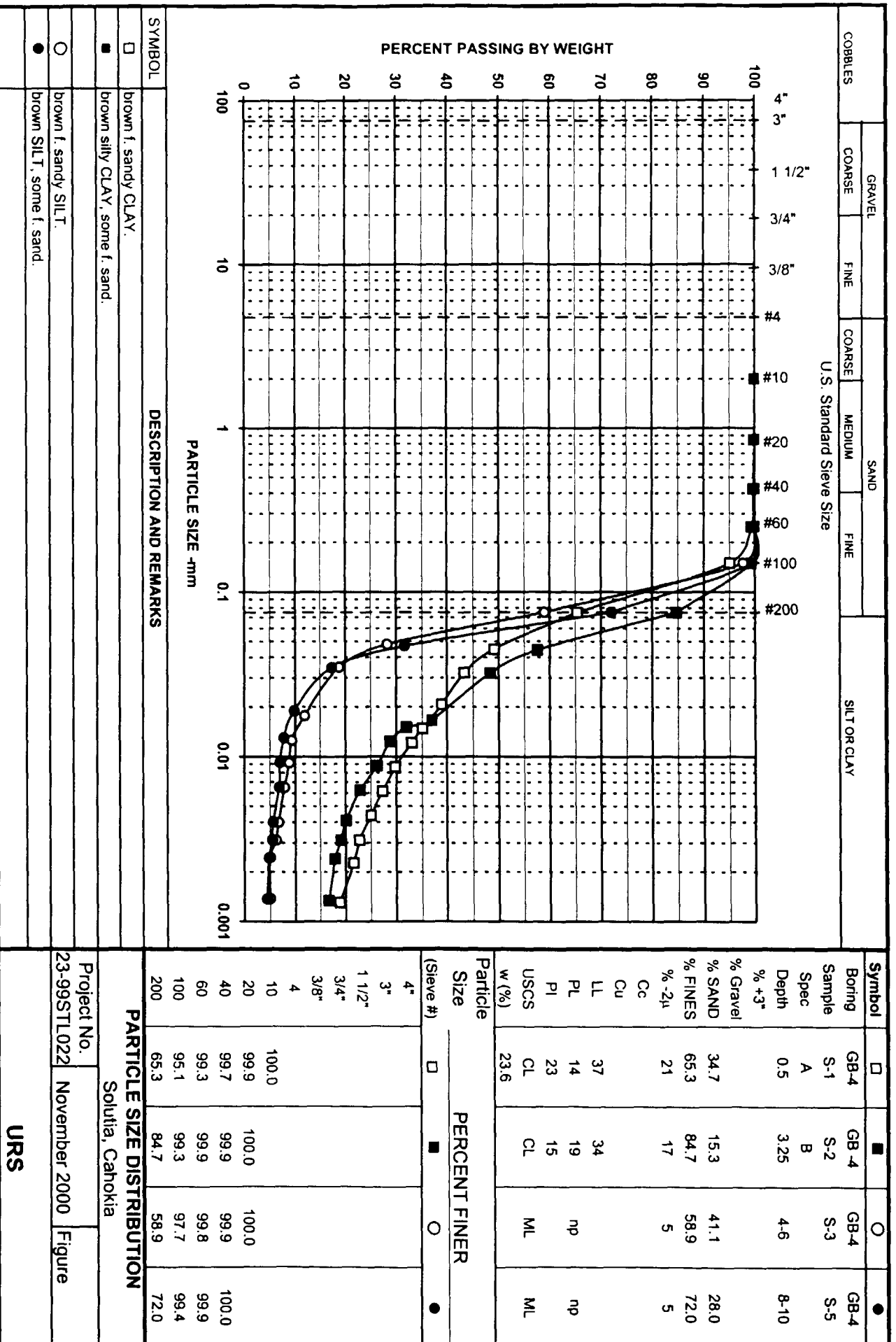


Figure A

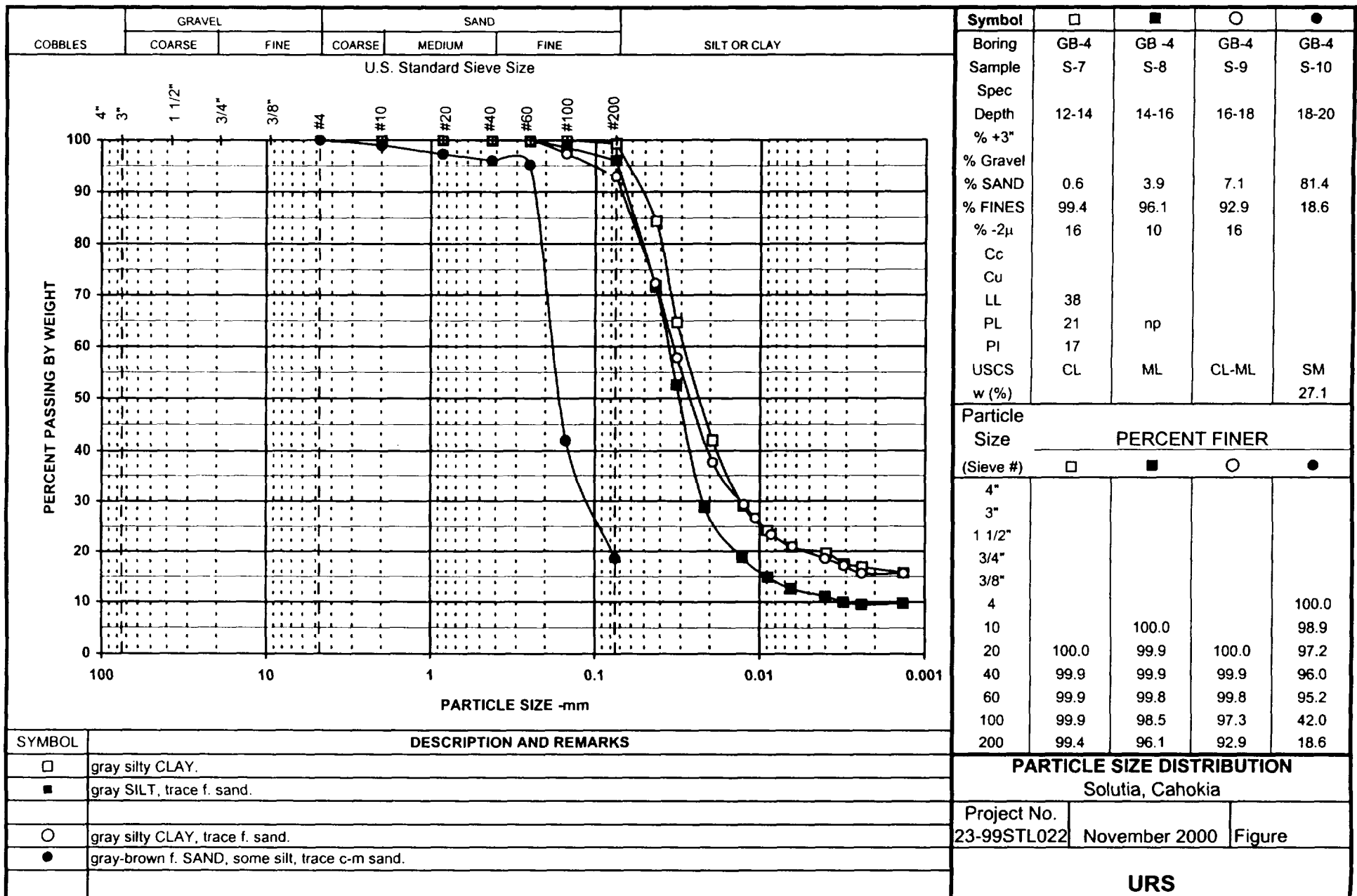


Figure A-21

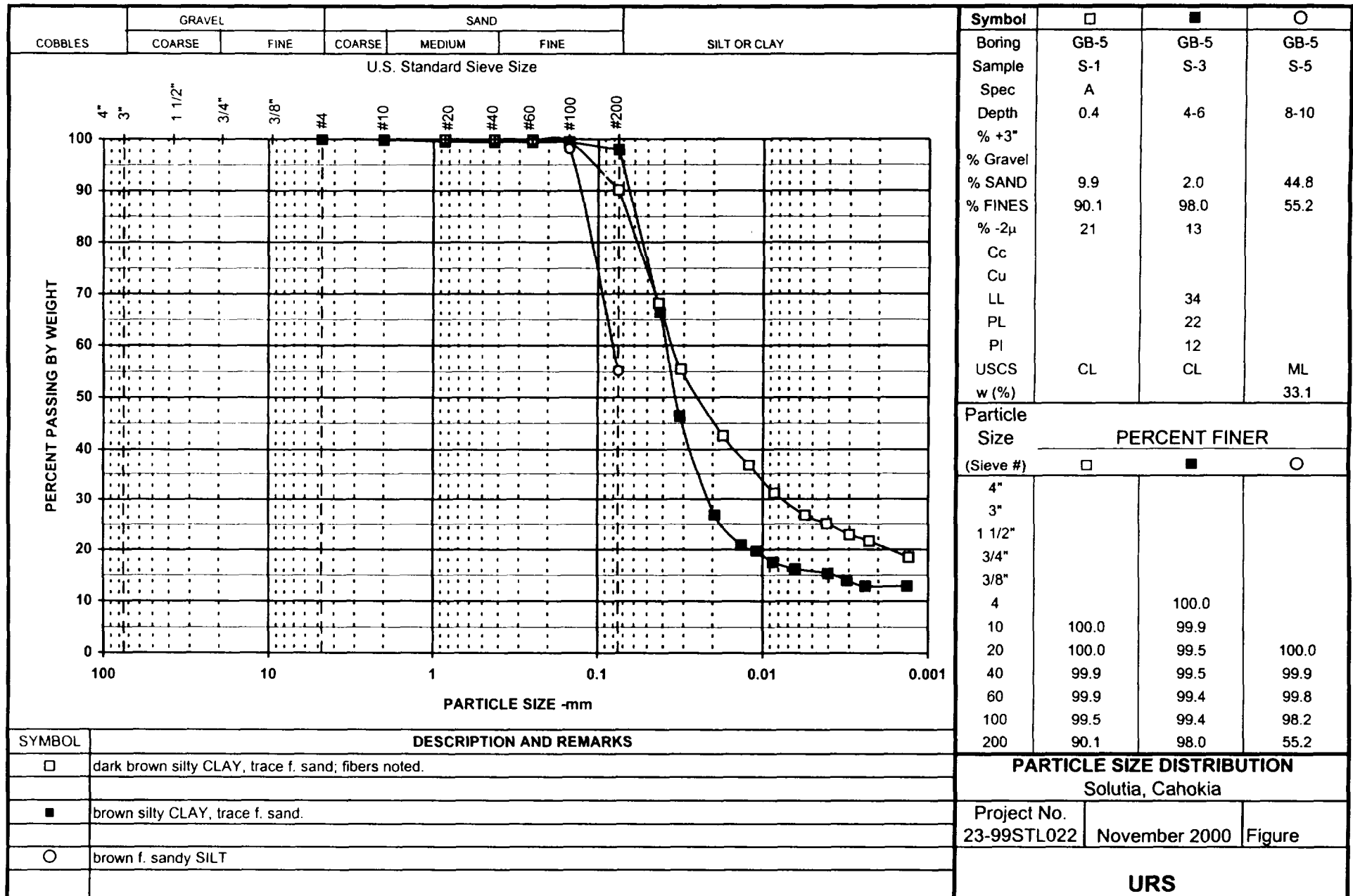


Figure A-2

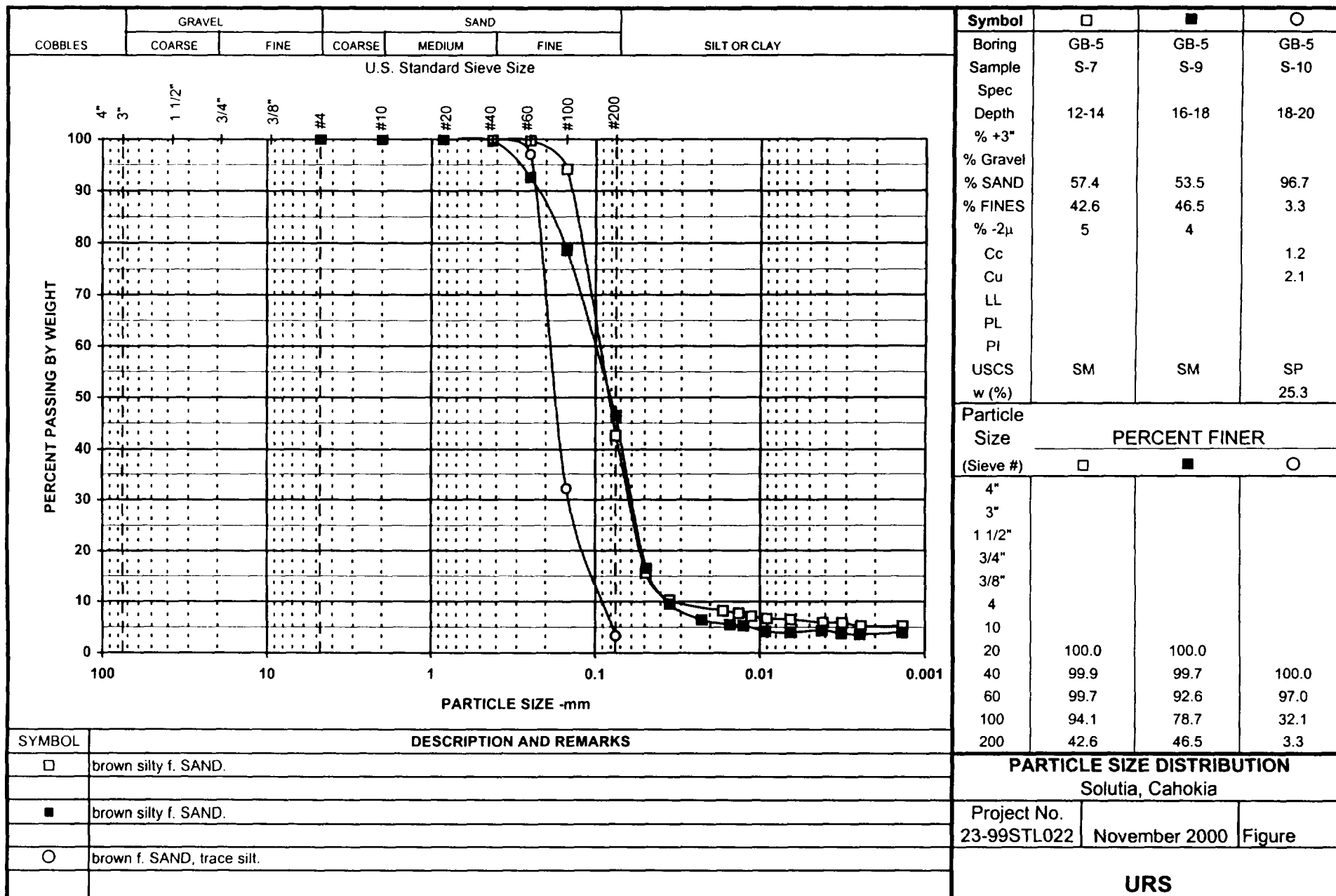
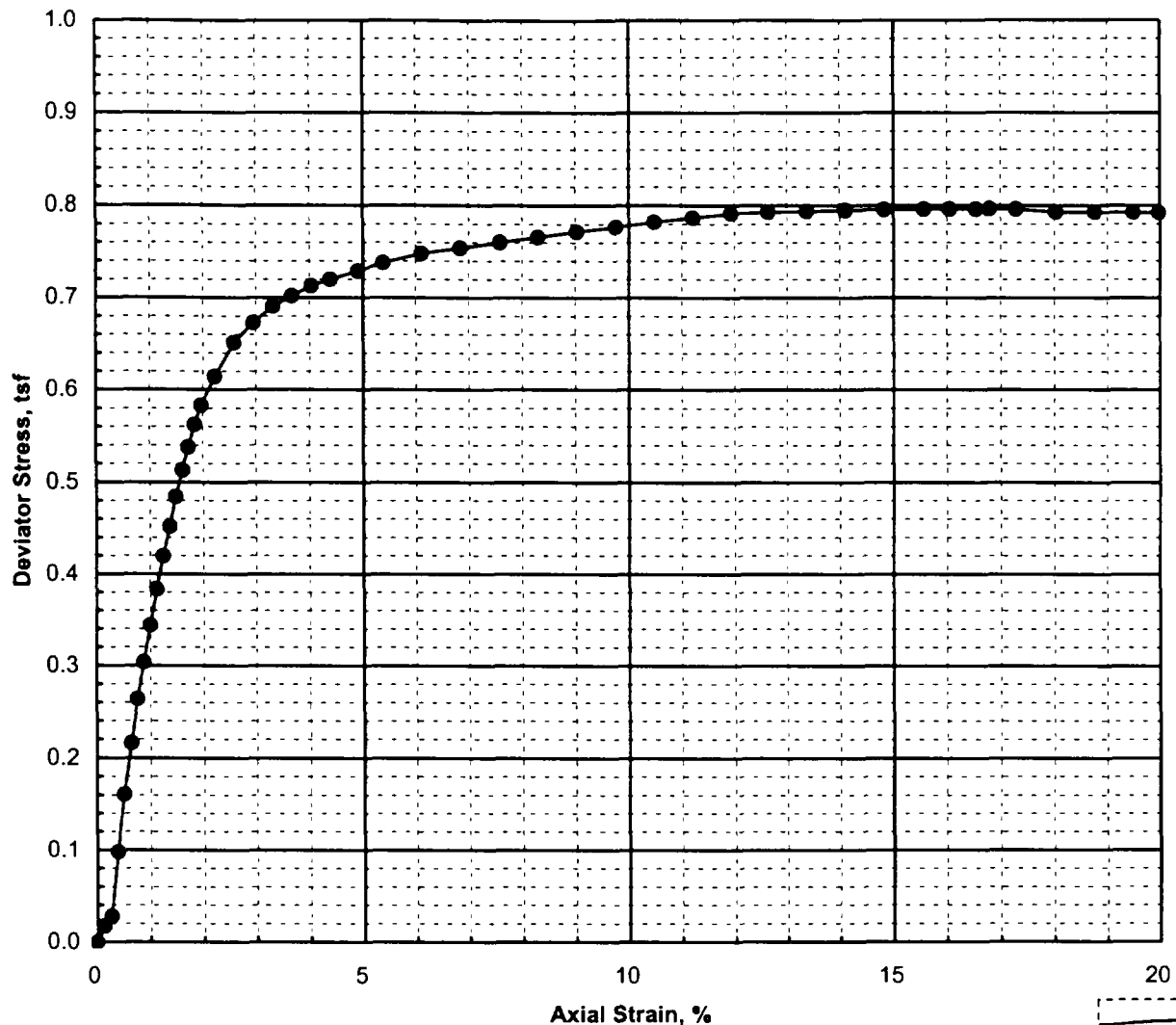


Figure A-23

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST ASTM D 5084 - 90																	
Project No. 23-99TL022.01 Project Name: Solutia, Cahokia				BORING: GP-4 SAMPLE: S-1C				DEPTH (ft): 1.55				Test No.: P5973					
Specimen - Apparatus set-up - Test Information																	
1) Specimen Tested in :		<input checked="" type="checkbox"/> Triaxial Cell or		<input type="checkbox"/> Compaction Mold or		<input type="checkbox"/> Stones with filter paper or		<input type="checkbox"/> top + bottom									
2) Specimen orientation for:		<input checked="" type="checkbox"/> Vertical or		<input type="checkbox"/> Horizontal permeability determination													
3) During saturation: Water flushed up sides of specimen to remove air:		<input checked="" type="checkbox"/> No		<input type="checkbox"/> Yes													
4) During consolidation:		<input checked="" type="checkbox"/> Top and bottom drainage or		<input type="checkbox"/> Top													
5) Direction of permeant :		<input checked="" type="checkbox"/> Up during or		<input type="checkbox"/> Down during permeation													
6) Permeant: water used		<input checked="" type="checkbox"/> Tap		<input type="checkbox"/> Distilled													
		<input type="checkbox"/> Demineralized		<input type="checkbox"/> 0.005 N calcium sulfate (CaSO ₄)													
Consol Stage	Temp. °C	Date	Time			Initial		Dial Indicator	Pressure Head Reading		Flow Reading	Flow Vol (cm ³)	Fluid Head Reading		Total Head	Gradient	Permeability
Trial No.			hr	min	sec	σ _c psi	U _b psi	in	Mercury (inch)	Gage (psi)	(cm)	Rate (cm ³ /sec)	Head (cm)	Tail (cm)	Uncorrected		Preliminary
initial	22.0	11/15/00	11	28	00	105.0	100.0	0.522			4.00	76.516	63.45	37.10	26.35		
final	22.0	11/15/00	11	42	31						7.70	0.0878	63.45	37.10	11.61		1.48E-03
1	RT = 0.952	dT =	14.52 min ✓			σ' _c =	0.7 ksf						63.45	37.1	14.74	1.46	1.42E-03
initial	22.0	11/15/00	11	43	00	105.0	100.0	0.522			3.10	64.108	63.45	37.10	26.35		
final	22.0	11/15/00	11	57	34						6.20	0.0734	63.45	37.10	11.24		1.21E-03
2	RT = 0.952	dT =	14.57 min ✓			σ' _c =	0.7 ksf						63.45	37.1	15.11	1.50	1.16E-03
initial	22.0	11/15/00	11	58	45	105.0	100.0	0.522			3.10	179.916	63.45	37.10	26.35		
final	22.0	11/15/00	12	33	00						11.80	0.0876	63.45	37.10	11.57		1.47E-03
3	RT = 0.952	dT =	34.25 min ✓			σ' _c =	0.7 ksf						63.45	37.1	14.78	1.46	1.41E-03
initial	22.0	11/15/00	12	35	00	105.0	100.0	0.522			3.70	74.448	63.45	37.10	26.35		
final	22.0	11/15/00	12	49	40						7.30	0.0846	63.45	37.10	11.18		1.39E-03
4	RT = 0.952	dT =	14.67 min ✓			σ' _c =	0.7 ksf						63.45	37.1	15.17	1.50	1.33E-03
Preliminary Length/Area Calculations						TEST SUMMARY						HYDRAULIC CONDUCTIVITY SUMMARY					
Lo = 3.997 in Lo = 10.153 cm Ao = 6.357 in ² Ao = 41.01 cm ² Vo = 25.410 in ³ Vo = 416.40 cm ³						Final Specimen and Test Conditions Lc = 10.097 cm ε _{axial} = 0.6% Ac = 40.347 cm ² Vc = 407.38 cm ³ ε _{vol} = 2.2%						Averages for trials: 1-4 ave K @ 20 °C: 1.33E-03 cm/sec (i ₀)ave = 1.48					
Lc = 10.097 cm Vc = 409.53 cm ³ Ac = 40.559 cm ²						w γ _t γ _d S (%) (pcf) (pcf) (%) Initial 14.13 100.3 87.9 41.9 PreTest 32.16 118.8 89.9 100.0						HYDRAULIC CONDUCTIVITY TEST					
Tested By: DT Reviewed By: G. Thomas																	

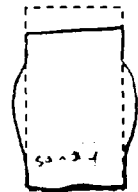
Figure A-24



Specimen Information

Water Content (%)	LL	PI	Length (in)	Diameter (in)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
23.6	37	23	6.040	2.840	113.1	91.5

CL, brown f. sandy CLAY; roots noted, sample more sandy towards bottom.



FAILURE SKETCH

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.50	0.35	0.80	15.58	0.73

Project No.
23-99STL022.01

Solutia, Cahokia

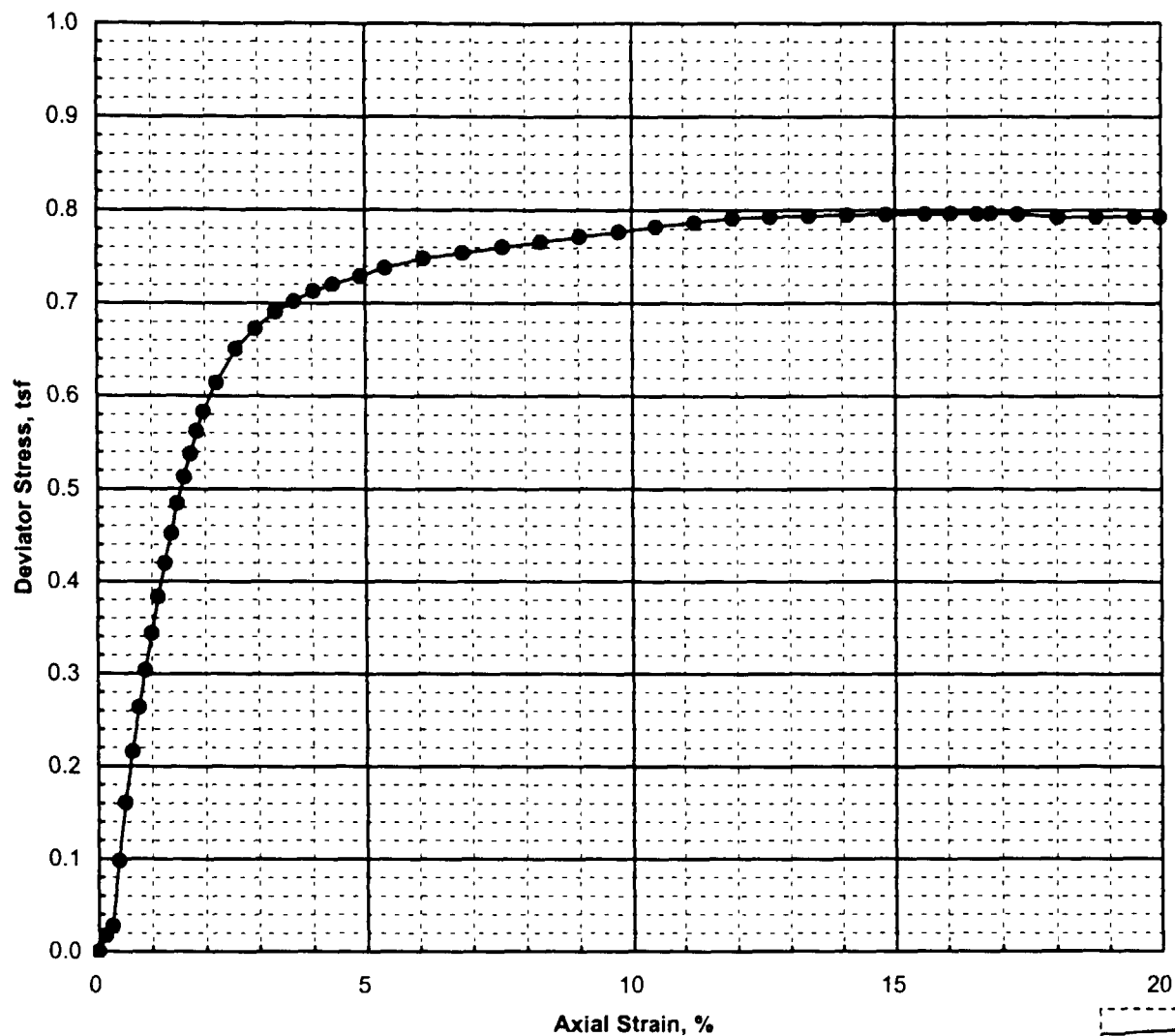
URS

**UNCONSOLIDATED-UNDRAINED
TRIAXIAL COMPRESSION TEST**

Boring No.: GB-4 Sample No.: S-1A
Depth (ft): 0.5

November 2000

Figure A-24



Specimen Information

Water Content (%)	LL	PI	Length (in)	Diameter (in)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
23.6	37	23	6.040	2.840	113.1	91.5

CL, brown f. sandy CLAY; roots noted, sample more sandy towards bottom.



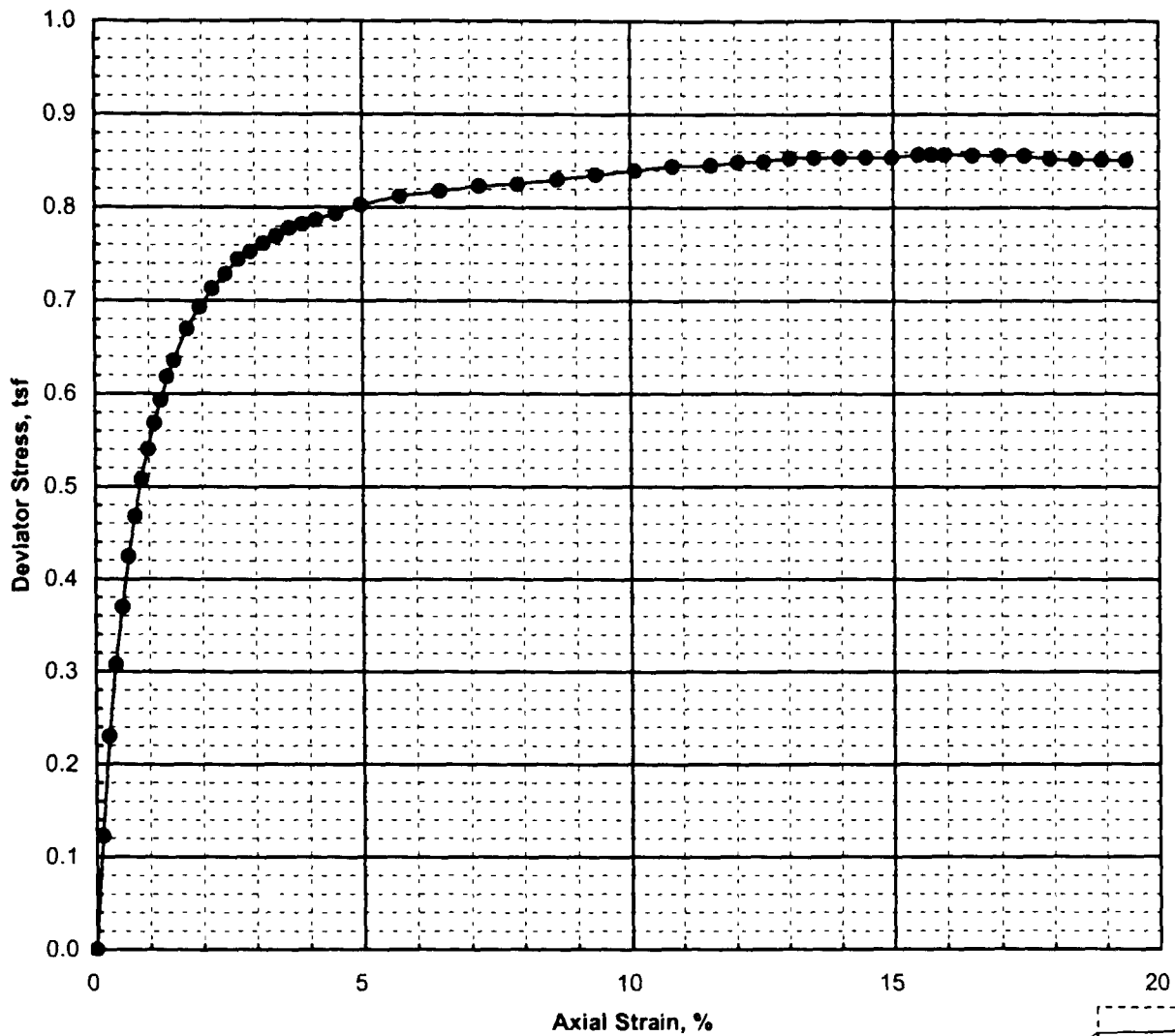
FAILURE SKETCH

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.50	0.35	0.80	15.58	0.73

Project No. 23-99STL022.01	Solutia, Cahokia	UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST	
URS		Boring No.: GB-4 Sample No.: S-1A Depth (ft): 0.5	November 2000

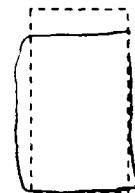
Figure A-25



Specimen Information

Water Content (%)	LL	PI	Length (in)	Diameter (in)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
26.4			6.014	2.850	112.3	88.9

CL, dark brown silty CLAY, trace f. sand.



FAILURE SKETCH

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
1.00	0.60	0.86	15.48	0.73

Project No. 23-99STL022.01	Solutia, Cahokia	UNCONSOLIDATED-UNDRAINED TRIAxIAL COMPRESSION TEST	
URS		Boring No.: GB-5 Sample No.: S-1A Depth (ft): 0.4	November 2000

Figure A

SAMPLE INFORMATION

Boring: GB-5
 Sample: S-1B
 Depth: 0.95 feet
 Elevation:
 Type: 3-inch thin wall tube
 Description: CL
 dark brown silty CLAY, some f. sand.
 LL = 36, PL = 24, PI = 12

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height: 0.61 inch
 Diameter: 2.50 inch

Initial water content: 28.1 %
 Initial total unit weight: 114.2 pcf
 Initial dry unit weight: 89.1 pcf
 Initial void ratio: 0.870
 Initial degree of saturation: 86 %

Final water content: 27.2 %
 Final total unit weight: 121.3 pcf
 Final dry unit weight: 95.3 pcf
 Final void ratio: 0.748
 Final degree of saturation: 97 % (measured specific gravity = 2.67)

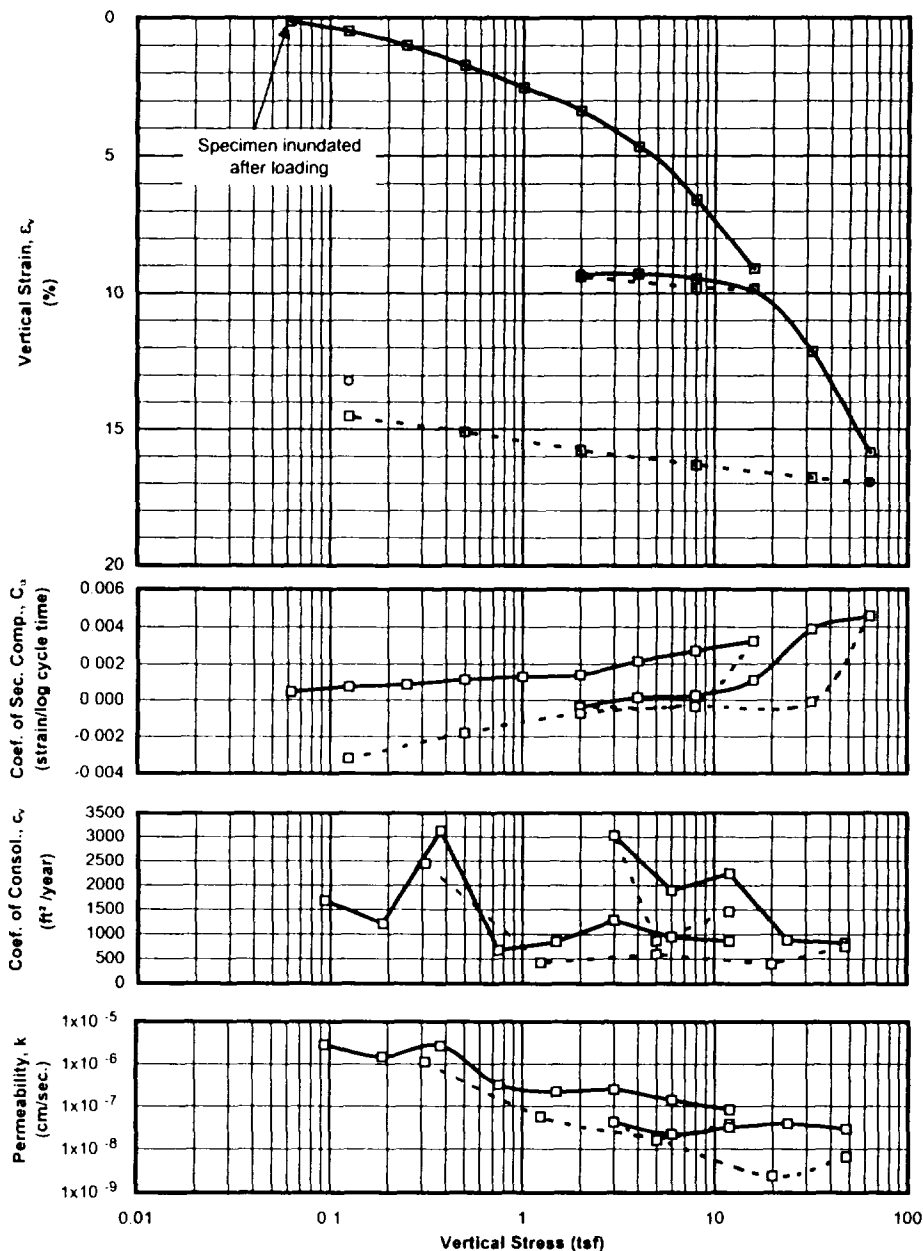
TEST SUMMARY

Construction Method: Casagrande (Log)
 Estimated preconsolidation stress (tsf): 10.2 (Range: 6.9 to 11.1)
 Estimated in situ effective overburden stress (tsf):
 Compression Ratio (strain per log cycle stress): 0.124
 Compression Index (void ratio per log cycle stress): 0.232
 Swell Ratio (strain per log cycle stress): 0.007
 Swell Index (void ratio per log cycle stress): 0.013
 Recompression Ratio (strain per log cycle stress): 0.009
 Recompression Index (void ratio per log cycle stress): 0.017
 Remarks:

LEGEND: □ End of primary ○ End of Stage — Loading - - - - - Unloading

Test Date: 11/16/00 Tested By: RR/CMJ Checked By: *11*

	Solutia, Cahokia	ONE DIMENSIONAL CONSOLIDATION TEST
		Boring: GB-5 Depth: 0.95 feet
URS Corporation	Project No. 23-99STL022.01	November 2000 Fig.



PROJECT:	Solutia, Cahokia				
PROJECT NO.:	23-99STL022.01	Initial height:	0.611 inch	Final height:	0.571 inch
BORING:	GB-5	Initial water content:	28.1 %	Final water content:	27.2 %
SAMPLE:	S-1B	Initial dry density:	89.1 pcf	Final dry density:	95.3 pcf
TEST:	C00150	Initial total density:	114.2 pcf	Final total density:	121.3 pcf
DEPTH, feet:	0.95	Initial saturation:	86 %	Final saturation:	97 %
BY:	RR/CMJ	Initial void ratio:	0.870	Final void ratio:	0.748
TEST DATE:	11/16/2000			Final strain:	6.5 %

EQUIPMENT:

Load Frame No.: 2
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CL

dark brown silty CLAY, some f. sand.

G	LL	PL	PI
2.67	36	24	12

Load No.	Load (tsf)	d ₁₀₀ (inch)	t ₁₀₀ Strain (%)	t ₁₀₀ Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c _v (ft ² /year)	C _α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0008	0.131	0.868	0.275	0.865	832.77	0.0004	47.75	5.26E-07
2	0.125	0.0030	0.484	0.861	0.785	0.856	1682.61	0.0007	17.69	2.87E-06
3	0.250	0.0061	0.994	0.852	1.222	0.847	1214.21	0.0008	24.50	1.49E-06
4	0.500	0.0105	1.716	0.838	2.157	0.830	3127.33	0.0011	34.66	2.72E-06
5	1.00	0.0154	2.524	0.823	2.975	0.815	673.82	0.0013	61.83	3.29E-07
6	2.00	0.0207	3.384	0.807	3.737	0.800	850.26	0.0014	116.35	2.20E-07
7	4.00	0.0284	4.656	0.783	5.213	0.773	1284.74	0.0022	157.27	2.46E-07
8	8.00	0.0402	6.586	0.747	7.280	0.734	949.99	0.0027	207.19	1.38E-07
9	16.0	0.0556	9.106	0.700	9.882	0.685	866.22	0.0032	317.54	8.23E-08
10	8.00	0.0599	9.798	0.687	9.758	0.688	1458.43	-0.0001	1155.19	3.81E-08
11	2.00	0.0574	9.398	0.694	9.303	0.696	870.52	-0.0004	1498.85	1.75E-08
12	4.00	0.0568	9.304	0.696	9.400	0.694	3029.10	0.0001	2133.85	4.28E-08
13	8.00	0.0578	9.459	0.693	9.571	0.691	1893.45	0.0003	2586.18	2.21E-08
14	16.0	0.0601	9.832	0.686	10.150	0.680	2240.16	0.0011	2141.75	3.16E-08
15	32.0	0.0742	12.140	0.643	13.093	0.625	889.28	0.0039	693.19	3.87E-08
16	64.0	0.0969	15.865	0.574	16.965	0.553	827.67	0.0046	859.17	2.91E-08
17	32.0	0.1026	16.794	0.556	16.769	0.557	754.47	-0.0001	3442.92	6.61E-09
18	8.00	0.0997	16.313	0.565	16.232	0.567	390.83	-0.0003	4990.62	2.36E-09
19	2.00	0.0964	15.773	0.575	15.569	0.579	595.65	-0.0007	1109.70	1.62E-08
20	0.500	0.0922	15.096	0.588	14.686	0.596	421.35	-0.0018	221.74	5.73E-08
21	0.125	0.0887	14.520	0.599	13.199	0.623	2446.85	-0.0032	65.06	1.13E-06

ATTACHMENT 5
SURFICIAL SOILS BEARING CAPACITY (Revised)

Job Solutia Target
Description _____

Project No. C1-3899.00

Computed by Gmm

Checked by JOH

Page ____ of ____

Sheet 1 of 3

Date 10 Jan 01

Date 11 Jan 01

Reference

Problem Re-evaluate site Bearing capacity using updated soil investigation

Soil Profile and Loading

$$q_{ult} = cN_c + \gamma D_f N_q + \frac{1}{2} \gamma B N_\gamma$$

for $\phi = 0 \pm D_f = 0$ $q_{ult} = cN_c$

for square surface load

$$q_{ult} = cN_c (1 + 3\frac{B}{L})$$

- Evaluate upper clayey strata

Global Bearing Capacity

$$q_{ult} = 5.14 (.44 \text{ tsf}) 1.3 = \underline{\underline{3.89 \text{ ksf}}}$$

Local Bearing Capacity

$$q_{ult} = 0.67 c N_c (1.3) = \underline{\underline{3.95 \text{ ksf}}}$$

- Evaluate layer effect

$$\frac{c_2}{c_1} = \frac{0.25}{0.44} = 0.57 \therefore N_c = 3 \quad (\text{Nasir, 1982})$$

$$\therefore q_{ult} = cN_c = 3 (.25 \text{ tsf}) 1.3 (2) = \underline{\underline{1.875 \text{ ksf}}}$$

Local failure

$$q_{ult} = 0.67 (3 (.25)) 1.3 (2) = \underline{\underline{1.307 \text{ ksf}}}$$

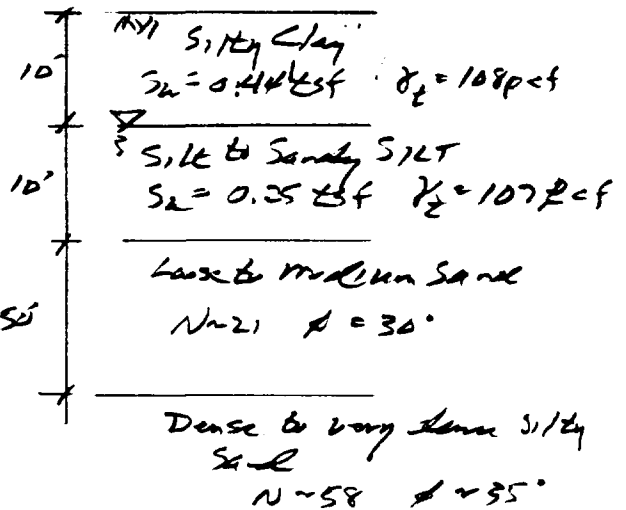


Table 1
Summary of Data for Key Strata

Solutia Inc. - Sauget Area 1
Cahokia, Illinois

Stratum	N (blows/ft)			w_{nat} (%)			LL (%)			PL (%)			γ_{tot} (pcf)			s_u (tsf)	P_c (tsf)	$C_c/(1+e_0)$	$C_r/(1+e_0)$	Minus	D_{10} (mm)	K (cm/sec)
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg					No. 200 (%)		
1	9	3	6	36	6	23	60	34	42	24	14	20	116	92	108	0.44	3	0.08	0.009	65-98	< 0.001	$10^{-6} - 10^{-7}$
2	10	0	5	37	6	26	38	32	35	25	19	22	115	89	107	0.25	3	0.10	0.012	18-99	< 0.001 - 0.02	$10^{-4} - 10^{-6}$
3	48	7	21	32	18	24	-	-	-	-	-	-	-	-	-	-	-	-	-	2-46	< 0.001 - 0.1	$10^{-3} - 10^{-4}$
4	79	37	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Description of Soil Strata:

1. Firm, moist, low to medium plastic, Silty CLAY (CL)
2. Very loose to loose, dry to wet, SILT to Sandy SILT (ML) with possibly some Clay lenses
3. Loose to medium dense, wet, Silty SAND to SAND (SM, SP)
4. Dense to very dense, wet, Silty SAND to SAND (SM, SP) with a trace of gravel

N - Number of blows per inch from standard penetration test

w_{nat} - Natural water content

LL - Liquid limit of material

PL - Plastic limit of material

γ_{tot} - Total unit weight of material

s_u - Undrained shear strength

P_c - Preconsolidation pressure

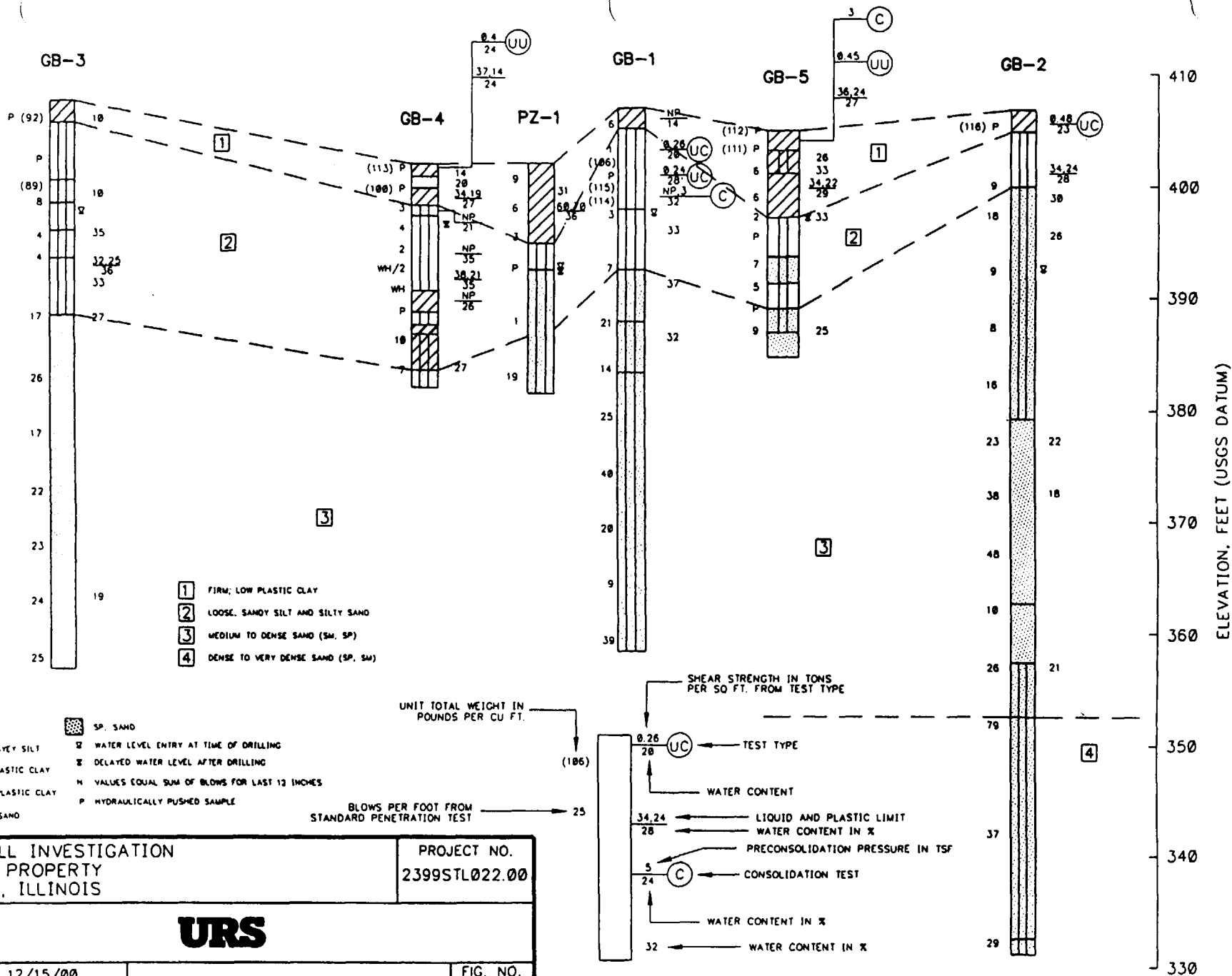
$C_c/(1+e_0)$ - Compression ratio, strain per log of stress beyond preconsolidation pressure

$C_r/(1+e_0)$ - Recompression ratio, strain per log of stress below preconsolidation pressure

No. 200 - Percentage passing the 200 sieve

D_{10} - Diameter at which 10% of the soil finer

K - Coefficient of permeability from consolidation test or estimate from gradation



TSCA CELL INVESTIGATION
 SOLUTIA PROPERTY
 CAHOKIA, ILLINOIS

PROJECT NO.
 2399STL022.00

URS

Subsurface Profile

FIG. NO.
 2

DRN. BY: djd 12/15/00
 DSGN. BY: lic
 CHKD. BY: [Signature]

ATTACHMENT 6
HYDROSTATIC UPLIFT CALCULATIONS

Job Solentia Sargent

Project No. C1-3899.00

Page of

Description Hydrostatic uplift

Computed by Gmn

Sheet 1 of 1

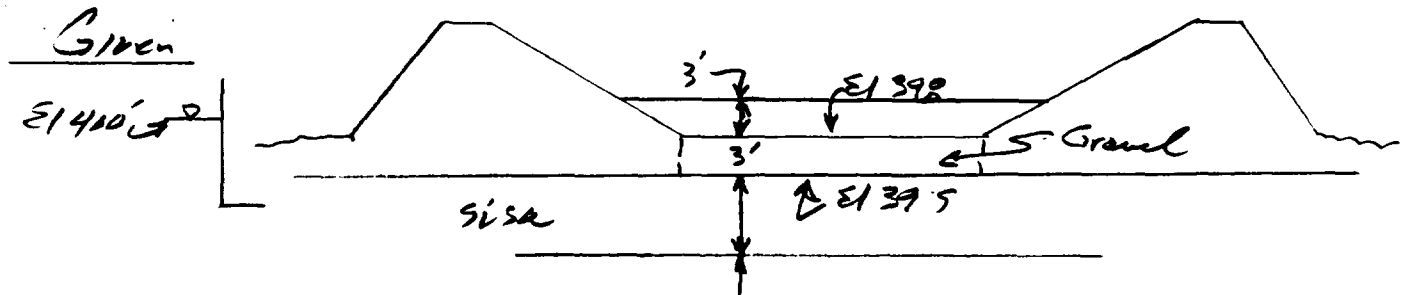
Checked by QPH

Date 10 Jan 01

Date 10-1-01

Reference

Problem Evaluate the potential for uplift on the
line system



Max observed water elevation = $E1400'$

Evaluate uplift potential for line system without
water in landfill

$\gamma_{\text{soil}} = 110 \text{ pcf}$

Load on gravel layer = $110 \text{ pcf} \times 3' = 330 \text{ psf}$

Uplift force from water = $62.4 \times 2' = 124 \text{ psf}$

Net downward
force

205 psf

ATTACHMENT 7
COMPATIBILITY STUDY

Compacted Soil
Geosynthetic Clay Liner
HDPE Geomembrane
Geotextile
Project Specific Leachate



GEOSYNTEC CONSULTANTS

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Web Site: www.interactionspecialists.com

January 2, 2001

Mr. Gary M. Wantland, P.E.
URS Greiner Woodward-Clyde
7650 West Courtney Campbell Causeway
Tampa, Florida 33607

Subject: Laboratory Test Results Transmittal
Permeability and Compatibility Testing
Samples: Soil and Geosynthetic Clay Liner (GCL)

Dear Mr. Wantland;

GeoSyntec Consultants (GeoSyntec) is pleased to present the attached test results for the above-mentioned project. The note section below addresses sample preparation, sample disposal and a disclosure statement.

GeoSyntec appreciates the opportunity to provide laboratory testing services for this project. Should you have any questions regarding the attached document(s), or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

Cuneyt Gokmen
Program Manager

Robert H. Swan, Jr.
Laboratory Manager

Attachment

Notes

- (1) Unless otherwise noted in the test results the sample(s)/specimen(s) were prepared in accordance with the applicable test standards or generally accepted sampling procedures.
- (2) Contaminated/chemical samples and all related laboratory generated waste (i.e., test liquids, PPE, absorbents, etc.) will be returned to the client or designated representative(s), at the client's cost, within 60 days following the completion of the testing program, unless special arrangements for proper disposal are made with GeoSyntec.
- (3) Materials that are not contaminated will be discarded after test specimens and archived specimens are obtained. Archived specimens will be discarded 60 days after the samples are received at the laboratory, unless long-term storage arrangements are specifically made with the laboratory.
- (4) The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analysis unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. The reported results are submitted for the exclusive use of the client to whom it is addressed.

GLI1096/SGI00199.TESTCOVLTR.DOC





GEOSYNTEC CONSULTANTS

Soil-Geosynthetic Interaction Testing Laboratory

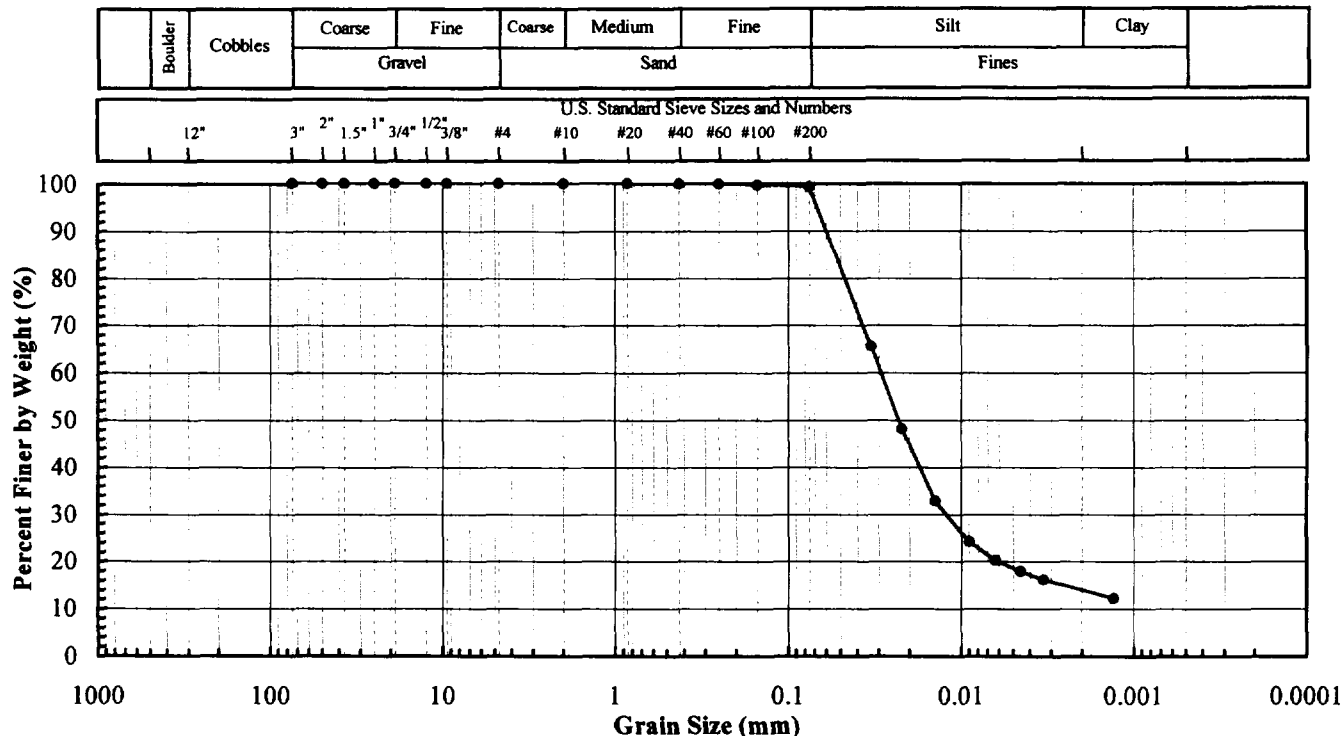
5775 Peachtree Dunwoody Road, Suite 11D, Atlanta, Georgia 30342
Ph: (404) 705 9500 Fax: (404) 705 9300

Project Name: Sauget Area 1 TSCA LF
Project No: GLI1096
Client Sample ID: Clay Liner Soil No. 1
Lab Sample No: AL7852

ASTM D 2216, D 1148, D 422,
C 136, D 4318, D 2487

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg
Limits, Classification

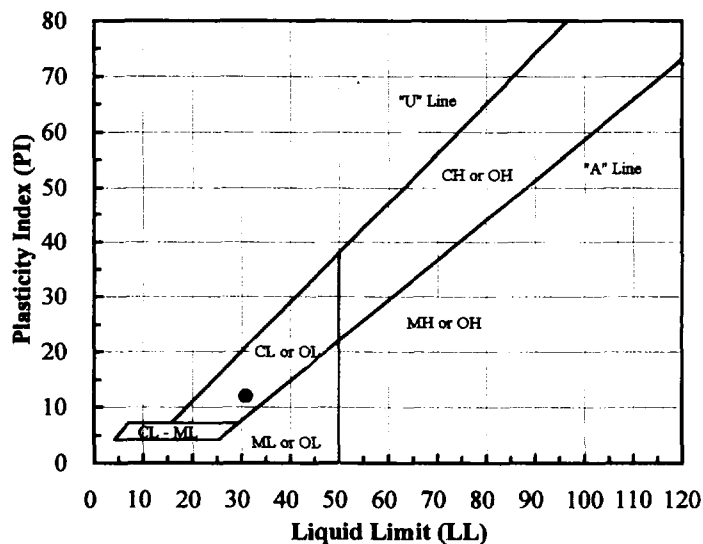


Sieve No.	Size (mm)	% Finer
3"	75	100
2"	50	100
1.5"	37.5	100
1"	25	100
3/4"	19	100
1/2"	12.5	100
3/8"	9.5	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	100
#100	0.150	100
#200	0.075	99

Hydrometer Particle Diameter (mm)	% Finer
0.050	83
0.020	46
0.005	18
0.002	14
0.001	

Gravel (%):	
Sand (%):	0.8
Fines (%):	99.2
Silt (%):	85.3
Clay (%):	13.9

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No.	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits			Engineering Classification
				LL (%)	PL (%)	PI (-)	
Clay Liner Soil No. 1	AL7852	14.9	99.2	31	19	12	CL - Lean Clay

Note(s):



GEOSYNTEC CONSULTANTS
Soil-Geosynthetic Interaction Testing Laboratory

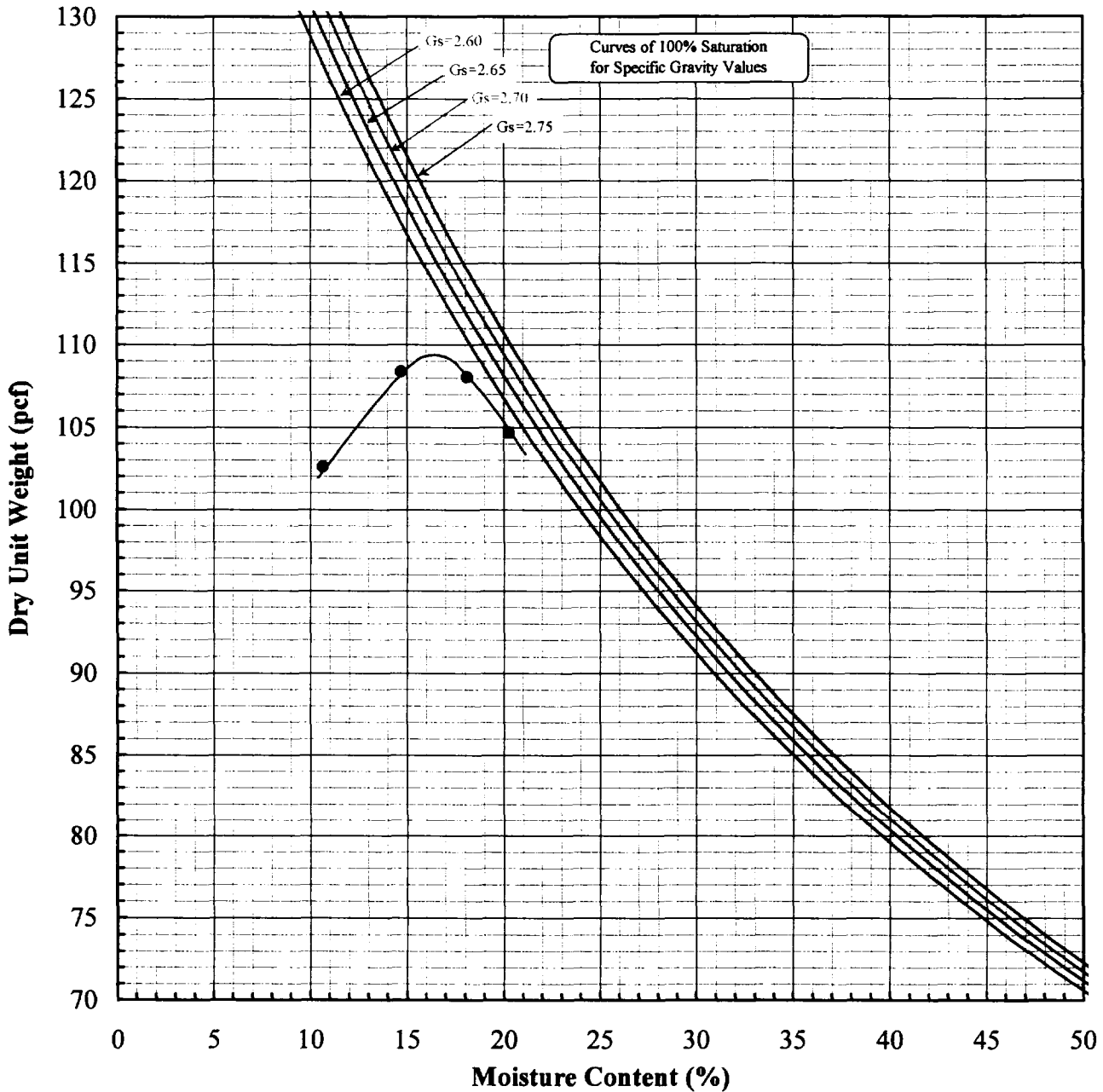
5775 Peachtree Dunwoody Road, Suite 11D, Atlanta, Georgia 30342
Ph: (404) 705 9500 Fax: (404) 705 9300

Project Name: Sauget Area 1 TSCA LF
Project No: GLI1096
Client Sample ID: Clay Liner Soil No. 1
Lab Sample No: AL7852

ASTM D698

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Standard - Method A



Client Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
Clay Liner Soil No. 1	AL7852	109.5	16.1	

Note(s):



GEOSYNTEC CONSULTANTS
Soil-Geosynthetic Interaction Testing Laboratory

5775 Peachtree Dunwoody Road, Suite 11D, Atlanta, Georgia 30342
Ph: (404) 705 9500 Fax: (404) 705 9300

FLEXIBLE WALL PERMEABILITY TEST⁽¹⁾
ASTM D5084 *

Project Name:	Sauget Area 1 TSCA LF
Project Number:	GLI1096
Client Project Number:	URS Job No. C100003899.00
Client/Site ID:	Clay Liner Soil No. 1
Sample Number:	AL7852
Material Type:	SOIL
Expected/Specified Value:	1E-7 cm/s

Specimen No.	Test Specimen Initial Conditions					Test Conditions					Hydraulic Conductivity (cm/s)
	Spec. Prep. ⁽²⁾ (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid ⁽³⁾ (-)	Average Gradient (-)	
1	R	5.78	7.27	104.4	16.2	90.0	75.0	15.0	DTW	9.5	1.3E-5
2	R	5.76	7.25	104.4	19.3	90.0	75.0	15.0	DTW	9.1	2.0E-6

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
3. Type of permeant liquid: DTW = Deaired Tap Water

*** Deviations:**

Laboratory temperature at 21±3 °C.

Test specimen final conditions are not presented.



GEOSYNTEC CONSULTANTS

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5775 Peachtree Dunwoody Road, Suite 11D
Atlanta, Georgia 30342 • USA
Tel. (404) 705-9500 • Fax (404) 705-9300
Web Site: www.interactionspecialists.com

January 2, 2001

Mr. Gary M. Wantland, P.E.
URS Greiner Woodward-Clyde
7650 West Courtney Campbell Causeway
Tampa, Florida 33607

Subject: Laboratory Test Results Transmittal
Soil Index, Compaction and Permeability Testing
Sample: Clay Liner Soil No. 1

Dear Mr. Wantland;

GeoSyntec Consultants (GeoSyntec) is pleased to present the attached test results for the above-mentioned project. The note section below addresses sample preparation, sample disposal and a disclosure statement.

GeoSyntec appreciates the opportunity to provide laboratory testing services for this project. Should you have any questions regarding the attached document(s), or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

Cuneyt Gokmen
Program Manager

Robert H. Swan, Jr.
Laboratory Manager

Attachment

Notes

- (1) Unless otherwise noted in the test results the sample(s)/specimen(s) were prepared in accordance with the applicable test standards or generally accepted sampling procedures.
- (2) Contaminated/chemical samples and all related laboratory generated waste (i.e., test liquids, PPE, absorbents, etc.) will be returned to the client or designated representative(s), at the client's cost, within 60 days following the completion of the testing program, unless special arrangements for proper disposal are made with GeoSyntec.
- (3) Materials that are not contaminated will be discarded after test specimens and archived specimens are obtained. Archived specimens will be discarded 60 days after the samples are received at the laboratory, unless long-term storage arrangements are specifically made with the laboratory.
- (4) The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analysis unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. The reported results are submitted for the exclusive use of the client to whom it is addressed.

GLI1096/SGI00203.TESTCOVLTR.DOC



SOIL

GEOSYNTEC CONSULTANTS
Soil-Geosynthetic Interaction Testing Laboratory

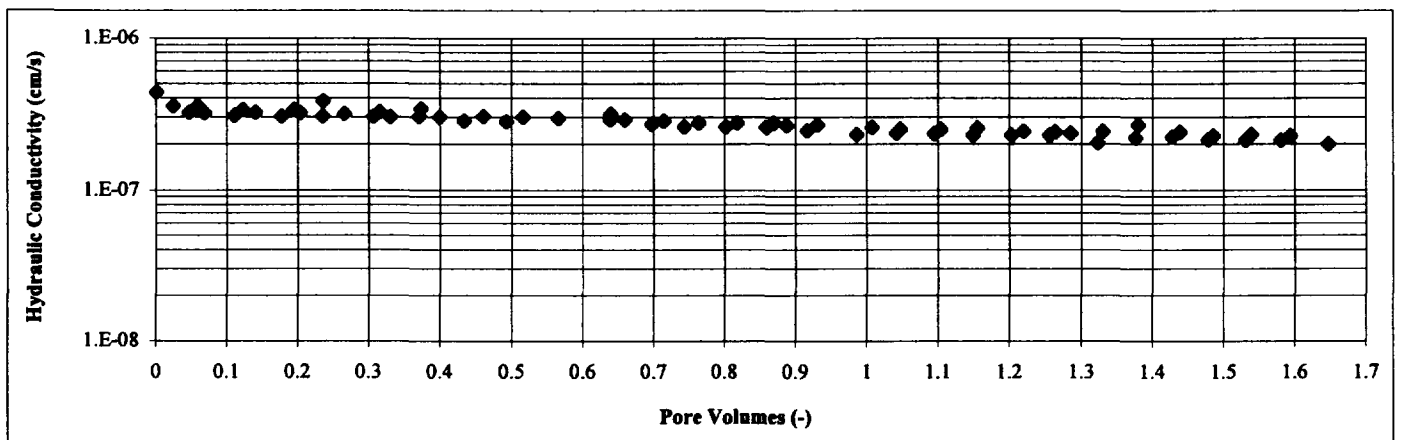
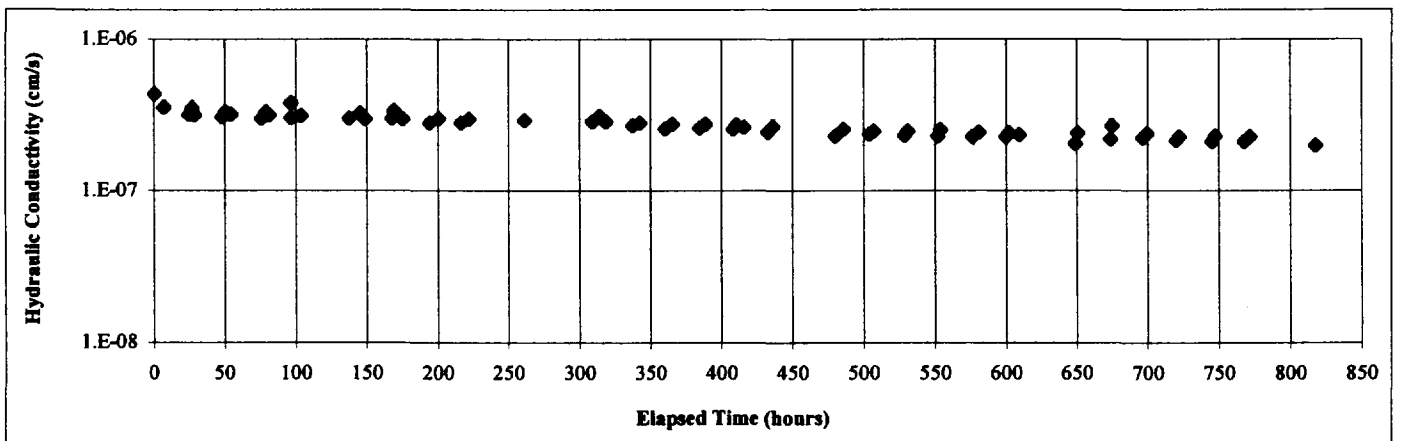
5775 Peachtree Dunwoody Road, Suite 11D, Atlanta, Georgia 30342

Ph: (404) 705 9500 Fax: (404) 705 9300

FLEXIBLE WALL PERMEABILITY TEST ⁽¹⁾
ASTM D5084 *

Project Name:	Solutia Site Compatibility Testing / Sauget Area 1 TSCA LF
Project Number:	GLI1096
Client Project Number:	C100003899
Client/Site ID:	Clay Liner Soil No. 1
Sample Number:	AL7852
Material Type:	Soil (Remolded)

Specimen No.	Test Specimen Conditions						Test Conditions					Hydraulic Conductivity (Note 4) (cm/s)
	Initial Final	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Porosity (Note 2) (-)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid ⁽³⁾ (-)	Average Gradient (-)	
1	Initial	7.56	7.17	103.9	19.3	0.38	75.7	60.7	15.0	SL	9.0	2.2E-7
	Final	7.54	7.12	105.2	22.0	0.36						



Notes:

- Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
Test specimen was hydrated, saturated, consolidated and permeated with the project specific synthetic leachate.
- For porosity and pore volume calculations, specific gravity was assumed to be 2.65.
- Type of permeant liquid: SL = Project Specific Synthetic Leachate
- Hydraulic conductivity value reported was calculated based on the average of the last eight measurements.

*** Deviations:**

Laboratory temperature at 21±3 °C.
AL7852.1.FWPerm.xls

Reviewed by:  Date: 12/20/00
Cuneyt Gokmen, Program Manager

GCL



GEOSYNTEC CONSULTANTS
Soil-Geosynthetic Interaction Testing Laboratory

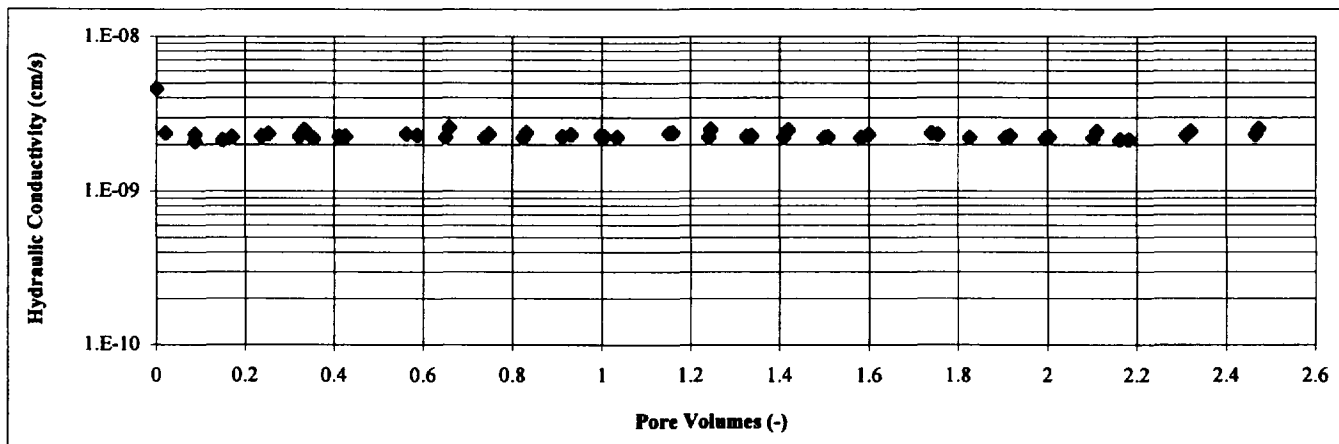
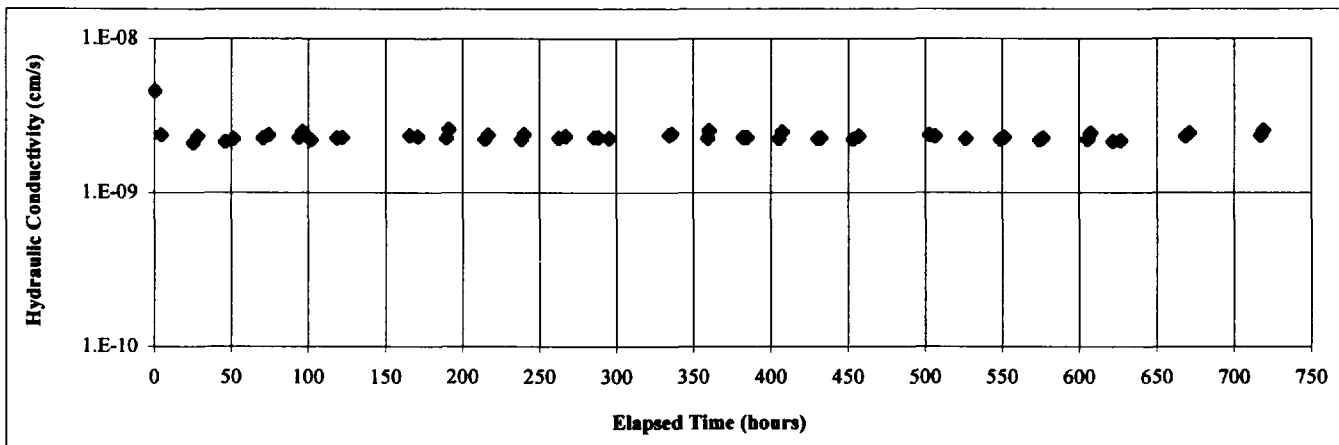
5775 Peachtree Dunwoody Road, Suite 11D, Atlanta, Georgia 30342

Ph: (404) 705 9500 Fax: (404) 705 9300

FLEXIBLE WALL PERMEABILITY TEST ⁽¹⁾
ASTM D5887 *

Project Name:	Solutia Site Compatibility Testing / Sauget Area 1 TSCA LF
Project Number:	GLH1096
Client Project Number:	C100003899
Client/Site ID:	Bentomat DN
Sample Number:	AL7854
Material Type:	GCL

Specimen No.	Test Specimen Conditions					Test Conditions					Hydraulic Conductivity (Note 4) (cm/s)
	Initial Final	Spec. Thick. (cm)	Spec. Diameter (cm)	Moisture Content (%)	Porosity (Note 2) (-)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Influent Pressure (psi)	Permeant Liquid ⁽³⁾ (-)	
1	Initial	0.88	10.67	14.8	-	80.0	75.0	5.0	77.0	SL	2.3E-9
	Final	0.63	10.69	114.6	0.67						



Notes:

- Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
 Test specimen was hydrated, saturated, consolidated and permeated with the project specific synthetic leachate.
- For porosity and pore volume calculations, specific gravity was assumed to be 2.65.
- Type of permeant liquid: SL = Project Specific Synthetic Leachate
- Hydraulic conductivity value reported was calculated based on the average of the last eight measurements.

*** Deviations:**

Laboratory temperature at 21±3 °C.
 AL7854.1.FWPerm.xls

Reviewed by:  Date: 12/27/00
 Cuneyt Gokmen, Program Manager



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Atlanta, Georgia 30342 • USA
Tel. (404) 705-9500 • Fax (404) 705-9300
Web Site: www.interactionspecialists.com

January 2, 2001

Mr. Gary M. Wantland, P.E.
URS Greiner Woodward-Clyde
7650 West Courtney Campbell Causeway
Tampa, Florida 33607

Subject: Laboratory Test Results Transmittal
Geosynthetic Material Chemical Compatibility Testing
Samples: Geomembrane and Geotextile

Dear Mr. Wantland;

GeoSyntec Consultants (GeoSyntec) is pleased to present the attached test results for the above-mentioned project. The note section below addresses sample preparation, sample disposal and a disclosure statement.

GeoSyntec appreciates the opportunity to provide laboratory testing services for this project. Should you have any questions regarding the attached document(s), or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

Cuneyt Gokmen
Program Manager

Robert H. Swan, Jr.
Laboratory Manager

Attachment

Notes

- (1) Unless otherwise noted in the test results the sample(s)/specimen(s) were prepared in accordance with the applicable test standards or generally accepted sampling procedures.
- (2) Contaminated/chemical samples and all related laboratory generated waste (i.e., test liquids, PPE, absorbents, etc.) will be returned to the client or designated representative(s), at the client's cost, within 60 days following the completion of the testing program, unless special arrangements for proper disposal are made with GeoSyntec.
- (3) Materials that are not contaminated will be discarded after test specimens and archived specimens are obtained. Archived specimens will be discarded 60 days after the samples are received at the laboratory, unless long-term storage arrangements are specifically made with the laboratory.
- (4) The reported results apply only to the materials and test conditions used in the laboratory testing program. The results do not necessarily apply to other materials or test conditions. The test results should not be used in engineering analysis unless the test conditions model the anticipated field conditions. The testing was performed in accordance with general engineering testing standards and requirements. The reported results are submitted for the exclusive use of the client to whom it is addressed.

GLI1096/SGI00198.TESTCOVLTR.DOC



GEOMEMBRANE



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CHEMICAL COMPATIBILITY TEST RESULTS

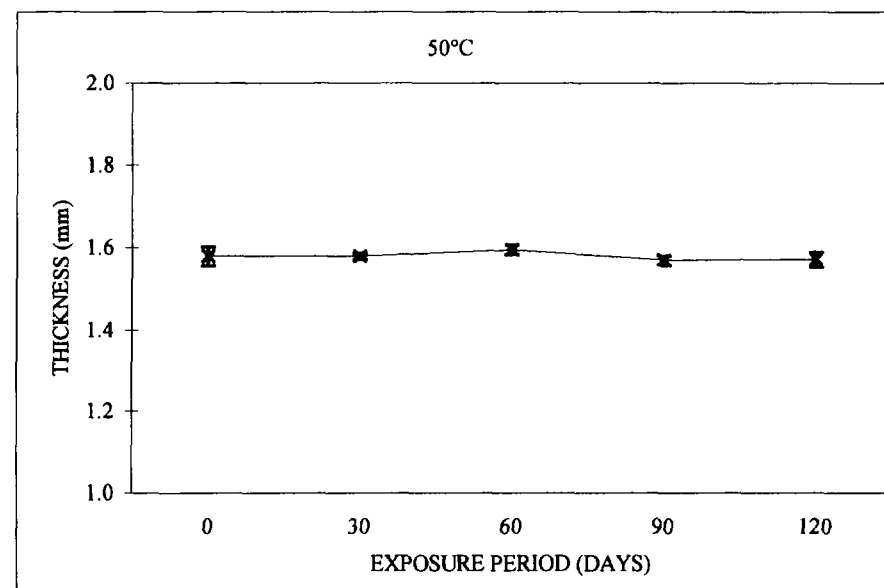
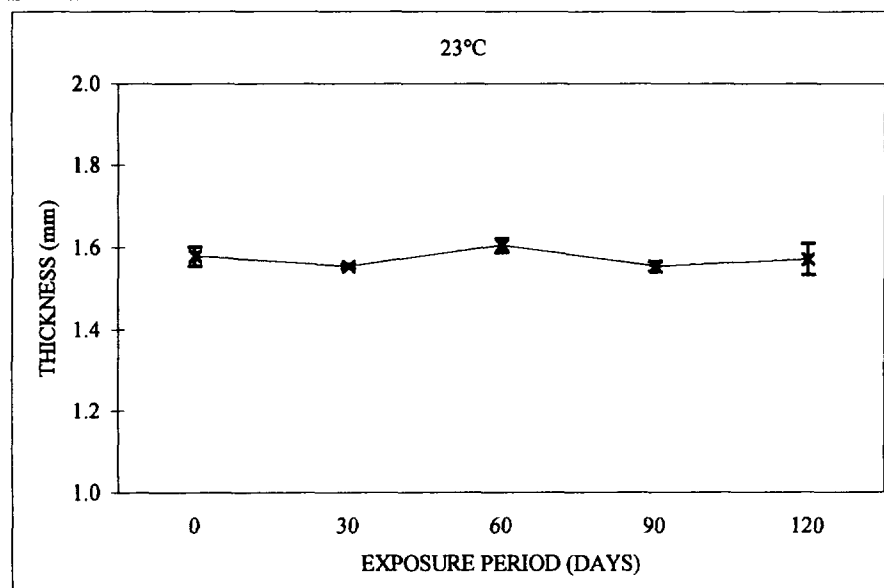
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GL11096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 5199

PROPERTY (UNIT): THICKNESS (mm)
DIRECTION: N/A

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control																			
	1.56	1.62	1.57	1.58	1.57	1.58	0.02	0.0	1.56	1.62	1.57	1.58	1.57	1.58	0.02	0.0			
	1.56	1.56	1.55	1.55		1.56	0.01	-1.6	1.58	1.59	1.58	1.57		1.58	0.01	0.0			
	1.62	1.59	1.60	1.63		1.61	0.02	1.7	1.60	1.59	1.59	1.61		1.60	0.01	1.0			
	1.54	1.55	1.57	1.56		1.56	0.01	-1.6	1.56	1.56	1.58	1.58		1.57	0.01	-0.6			
	1.60	1.55	1.61	1.53		1.57	0.04	-0.5	1.60	1.56	1.56	1.57		1.57	0.02	-0.5			



Note: Error bars represent one standard deviation at mean sample value.

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Reviewed by: Date: 12/21/00
Cuneyt Gokmen, Program Manager



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CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

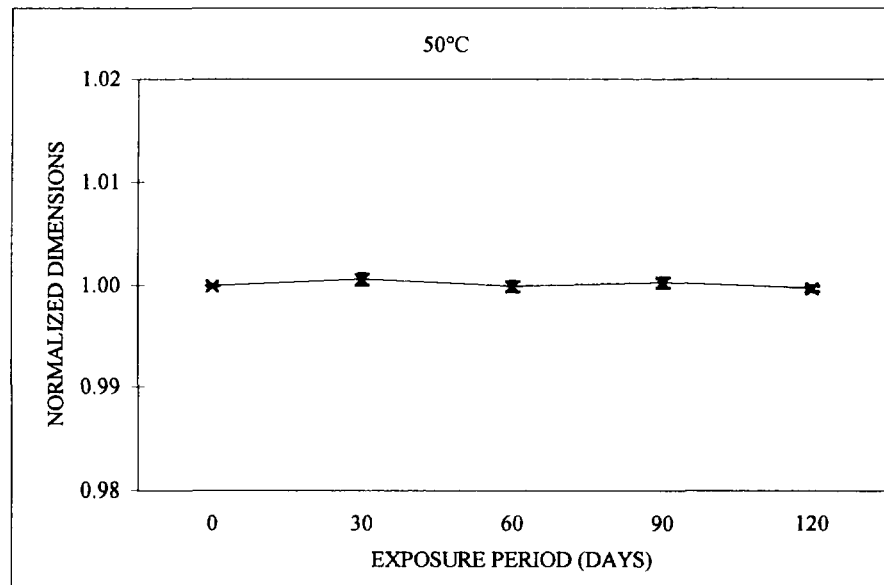
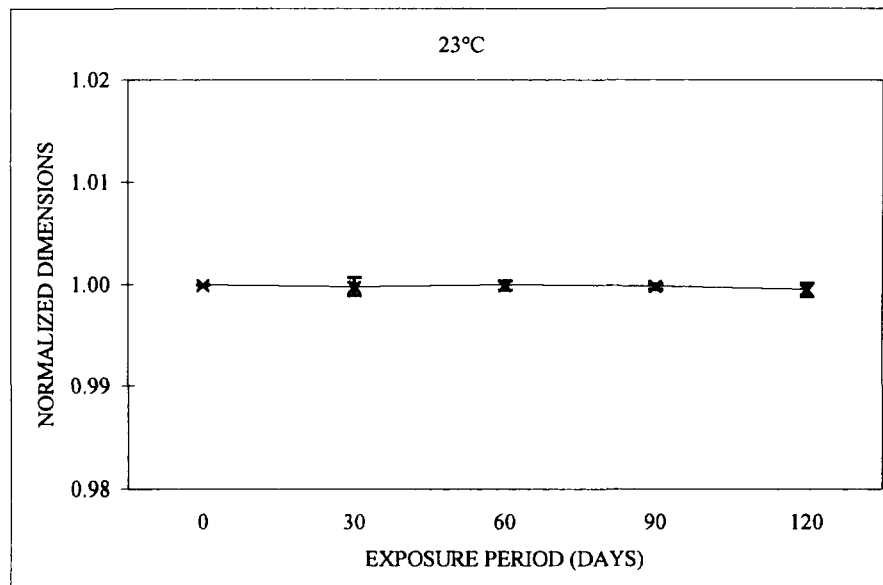
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: EPA 9090

PROPERTY (UNIT): NORMALIZED DIMENSIONS (FINAL LENGTH/INITIAL LENGTH)

DIRECTION: ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Standard Percent			Specimens					Standard Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change	
Control	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	
	1.0004	0.9985	1.0000	1.0004		0.9998	0.0009	-0.02	1.0001	1.0007	1.0002	1.0013		1.0006	0.0005	0.06	
	0.9993	1.0003	1.0001	1.0002		1.0000	0.0005	0.00	1.0003	0.9997	0.9993	1.0003		0.9999	0.0005	-0.01	
	0.9996	0.9996	1.0000	1.0002		0.9999	0.0003	-0.01	1.0003	1.0007	0.9996	1.0005		1.0003	0.0005	0.03	
	0.9992	1.0001	1.0001	0.9988		0.9996	0.0007	-0.04	0.9996	0.9997	1.0001	0.9994		0.9997	0.0003	-0.03	



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

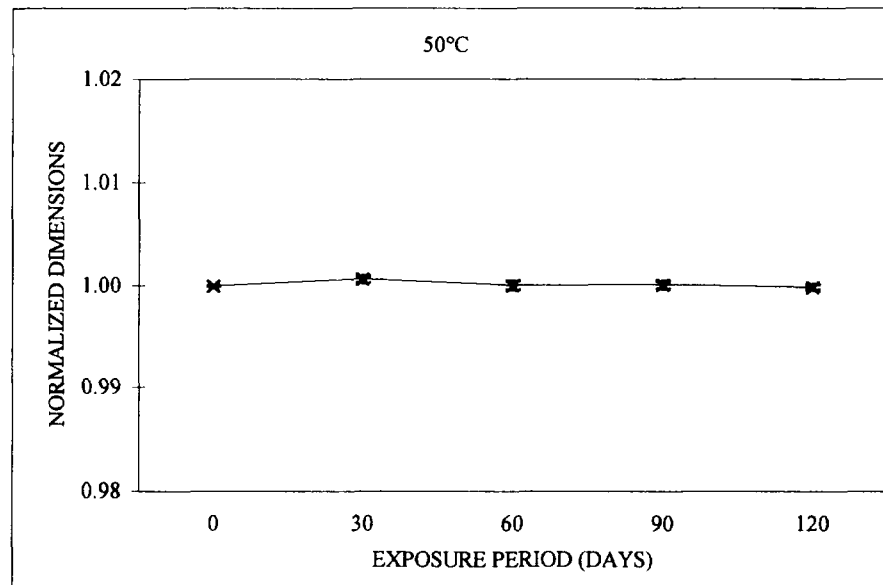
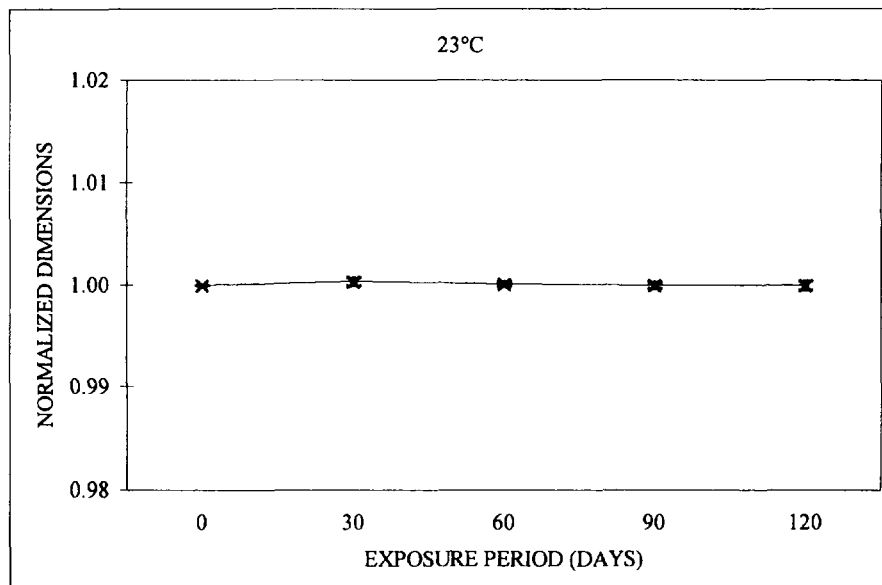
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: EPA 9090

PROPERTY (UNIT): NORMALIZED DIMENSIONS (FINAL LENGTH/INITIAL LENGTH)

DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C								50°C								Remarks							
	Specimens					Standard			Percent			Specimens						Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change		1	2	3	4	5	Mean	Deviation
Control	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00								
	1.0008	1.0004	1.0003	0.9999		1.0004	0.0004	0.04	1.0010	1.0002	1.0005	1.0008		1.0006	0.0004	0.06								
	1.0003	0.9998	1.0002	1.0003		1.0001	0.0002	0.01	1.0005	0.9995	1.0003	0.9998		1.0000	0.0005	0.00								
	1.0003	1.0000	1.0002	0.9996		1.0000	0.0003	0.00	1.0003	1.0005	0.9997	0.9999		1.0001	0.0004	0.01								
	120	0.9998	1.0004	0.9995	1.0003		1.0000	0.0004	0.00	0.9995	1.0001	1.0001	0.9998		0.9999	0.0003	-0.01							



Note: Error bars represent one standard deviation at mean sample value.

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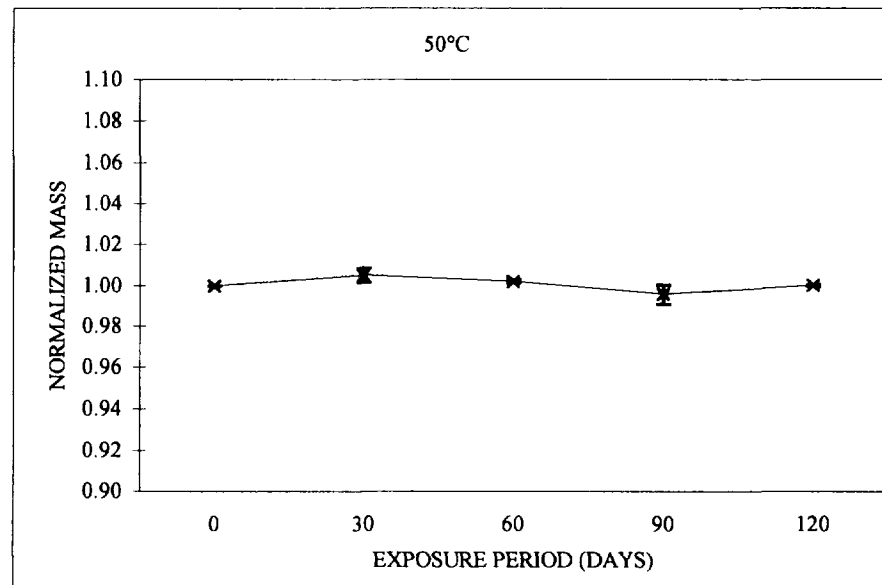
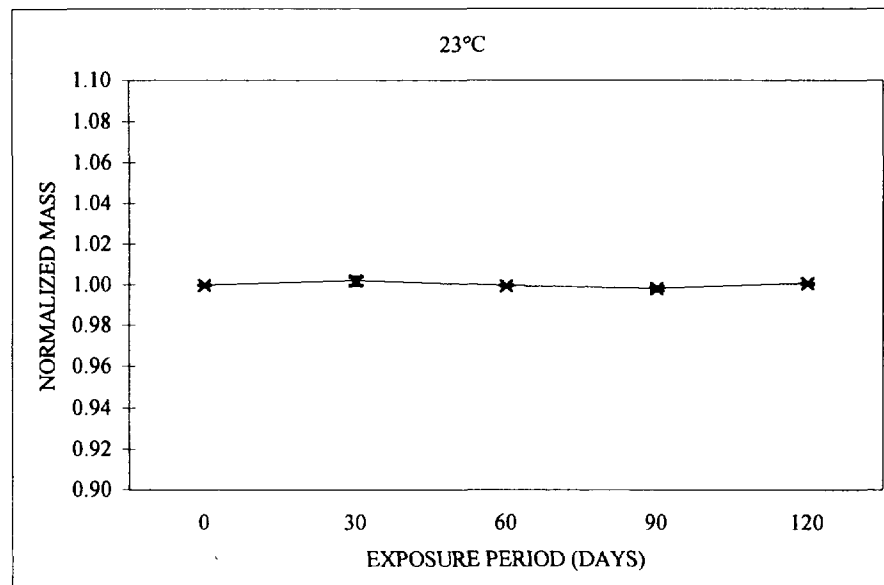
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: EPA 9090

PROPERTY (UNIT): NORMALIZED MASS (FINAL MASS/INITIAL MASS)
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks							
	Specimens					Standard			Percent			Specimens						Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change		1	2	3	4	5	Mean	Deviation
Control	1.0000	1.0000				1.0000	0.0000	0.00	1.0000	1.0000				1.0000	0.0000	0.00								
30	1.0007	1.0034				1.0021	0.0019	0.21	1.0027	1.0075				1.0051	0.0034	0.51								
60	1.0000	0.9997				0.9998	0.0002	-0.02	1.0027	1.0017				1.0022	0.0007	0.22								
90	0.9990	0.9976				0.9983	0.0010	-0.17	0.9990	0.9923				0.9957	0.0047	-0.43								
120	1.0010	1.0007				1.0008	0.0002	0.08	1.0000	1.0003				1.0002	0.0002	0.02								



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

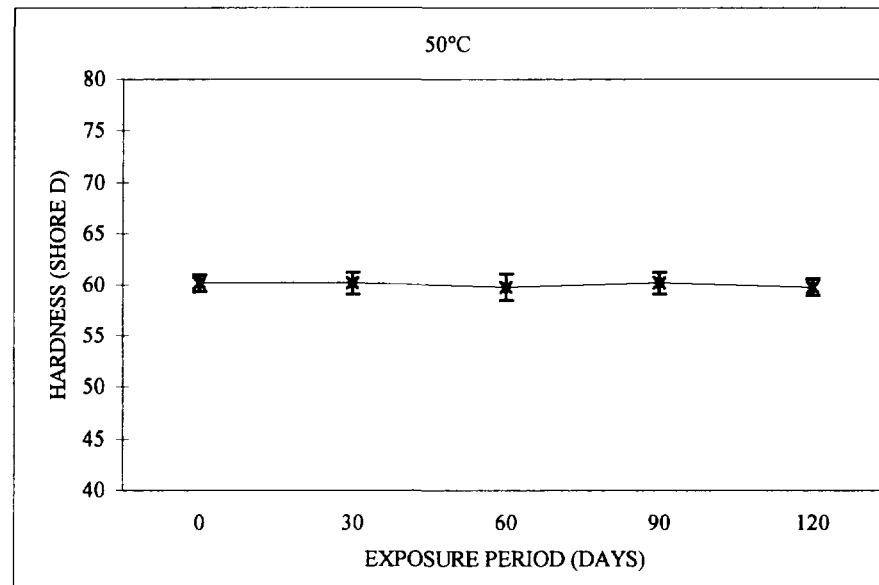
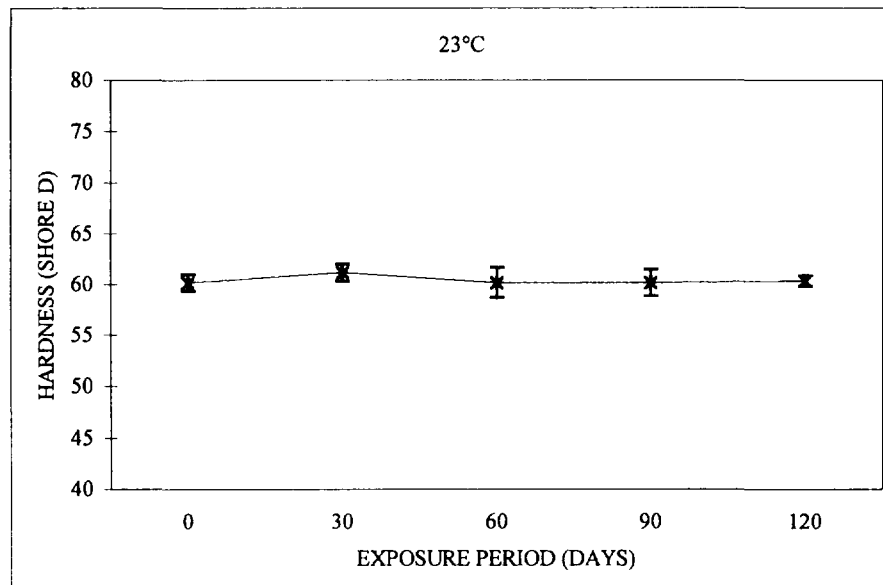
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 2240

PROPERTY (UNIT): HARDNESS (SHORE D)

DIRECTION: N/A

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control 30 60 90 120																			
	60	61	60	61	59	60.2	0.8	0.0	60	61	60	61	59	60.2	0.8	0.0			
	61	62	60	61	62	61.2	0.8	1.7	60	60	62	60	59	60.2	1.1	0.0			
	58	62	60	61	60	60.2	1.5	0.0	59	61	61	58	60	59.8	1.3	-0.7			
	62	61	59	59	60	60.2	1.3	0.0	60	60	62	60	59	60.2	1.1	0.0			
	60	61	61	60	60	60.4	0.5	0.3	59	59	60	60	61	59.8	0.8	-0.7			



Note: Error bars represent one standard deviation at mean sample value.

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CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

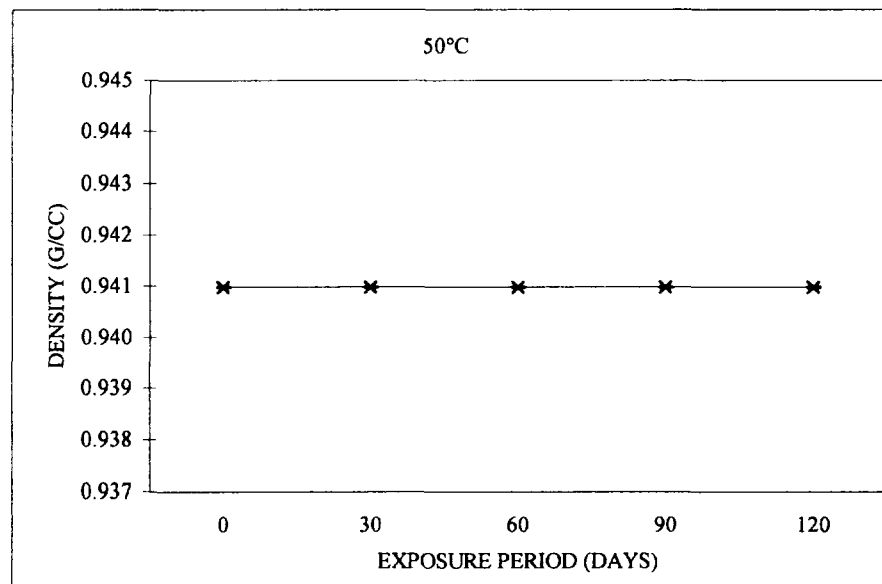
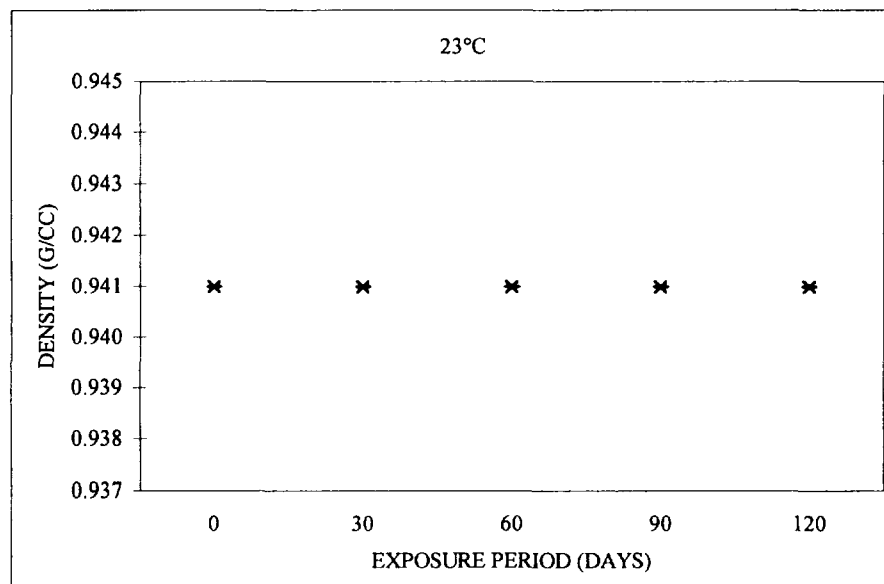
CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 1505

PROPERTY (UNIT): DENSITY (G/CC)
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks						
	Specimens					Standard			Percent			Specimens						Standard			Percent		
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change							
Control	0.941	0.941	0.941			0.941	0.000	0.0	0.941	0.941	0.941			0.941	0.000	0.0							
	0.941	0.941	0.941			0.941	0.000	0.0	0.941	0.941	0.941			0.941	0.000	0.0							
	0.941	0.941	0.941			0.941	0.000	0.0	0.941	0.941	0.941			0.941	0.000	0.0							
	0.941	0.941	0.941			0.941	0.000	0.0	0.941	0.941	0.941			0.941	0.000	0.0							
	0.941	0.941	0.941			0.941	0.000	0.0	0.941	0.941	0.941			0.941	0.000	0.0							



Note: Error bars represent one standard deviation at mean sample value.

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CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

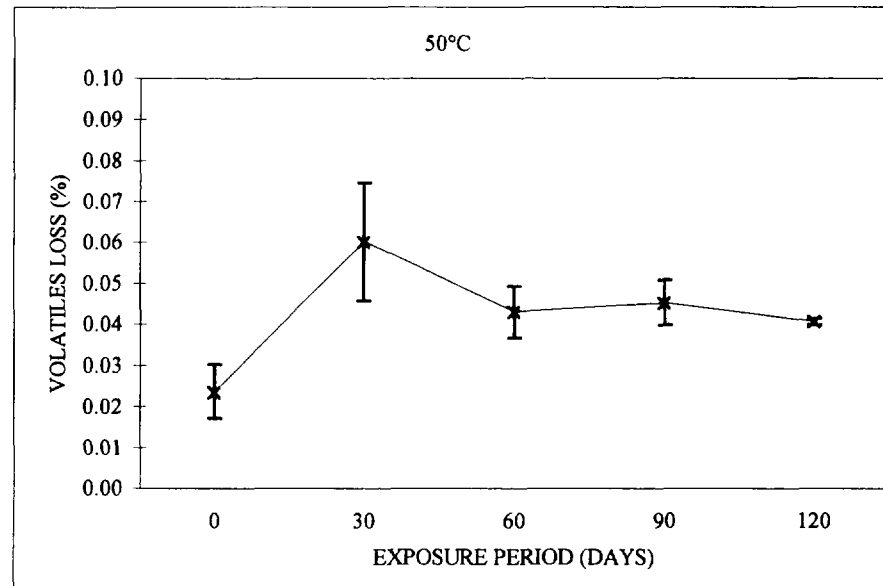
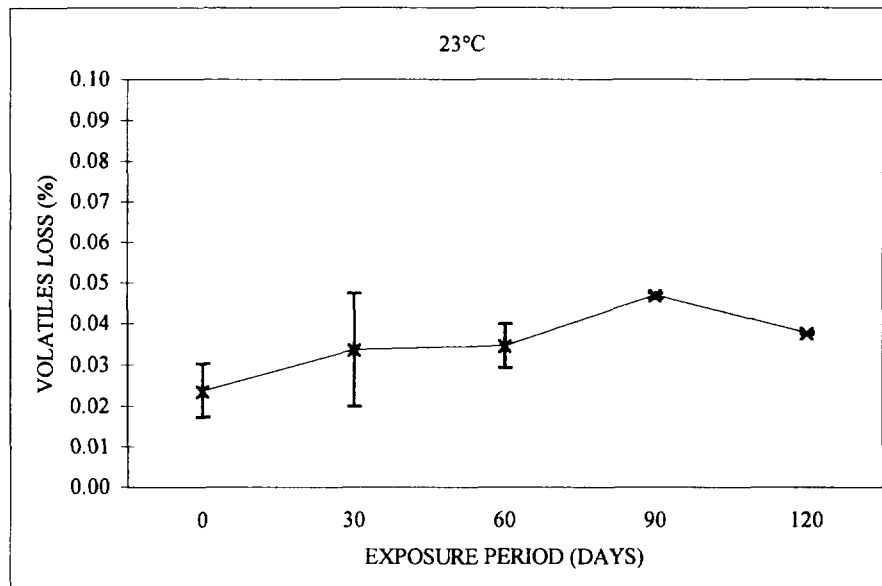
CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: EPA 9090

PROPERTY (UNIT): VOLATILES LOSS (%)
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Standard			Specimens					Standard			
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change	
Control	0.0192	0.0284				0.0238	0.0065	0.0	0.0192	0.0284				0.0238	0.0065	0.0	
	0.0240	0.0435				0.0338	0.0138	41.8	0.0499	0.0704				0.0602	0.0145	152.7	
	0.0309	0.0384				0.0347	0.0053	45.6	0.0386	0.0475				0.0431	0.0063	80.9	
	0.0475	0.0465				0.0470	0.0007	97.5	0.0492	0.0414				0.0453	0.0055	90.3	
	0.0380	0.0377				0.0379	0.0002	59.0	0.0413	0.0402				0.0408	0.0008	71.2	



Note: Error bars represent one standard deviation at mean sample value.

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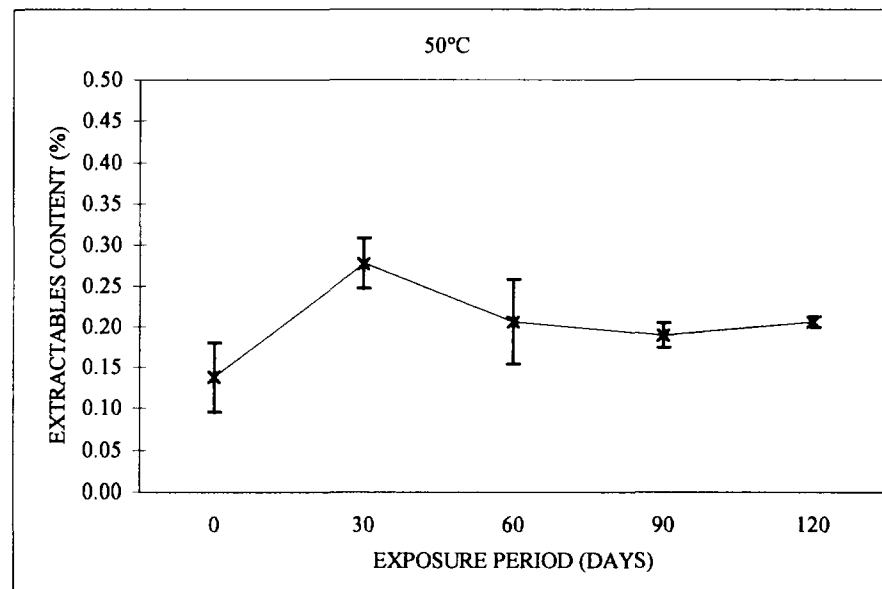
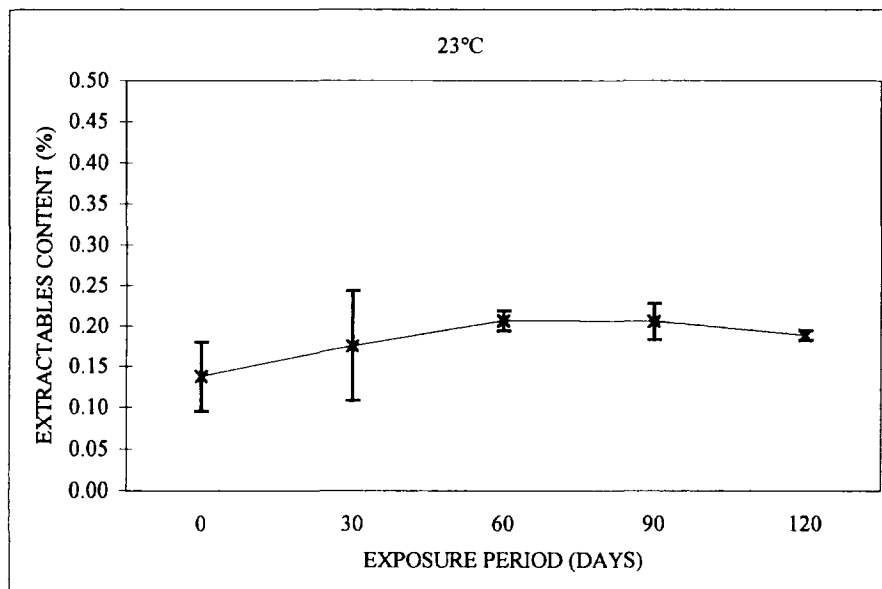
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: EPA 9090

PROPERTY (UNIT): EXTRACTABLES CONTENT (%)
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks							
	Specimens					Standard			Percent			Specimens						Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change		1	2	3	4	5	Mean	Deviation
Control	0.1682	0.1079				0.1381	0.0426	0.0	0.1682	0.1079				0.1381	0.0426	0.0								
30	0.1281	0.2236				0.1759	0.0675	27.4	0.2995	0.2563				0.2779	0.0305	101.3								
60	0.2162	0.1985				0.2074	0.0125	50.2	0.2427	0.1689				0.2058	0.0522	49.1								
90	0.2219	0.1903				0.2061	0.0223	49.3	0.2008	0.1794				0.1901	0.0151	37.7								
120	0.1851	0.1933				0.1892	0.0058	37.1	0.2016	0.2112				0.2064	0.0068	49.5								



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

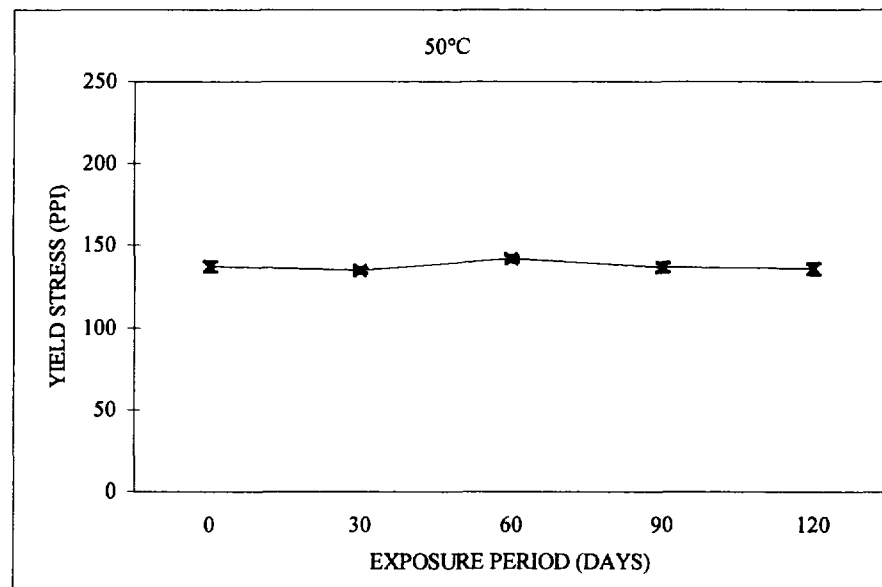
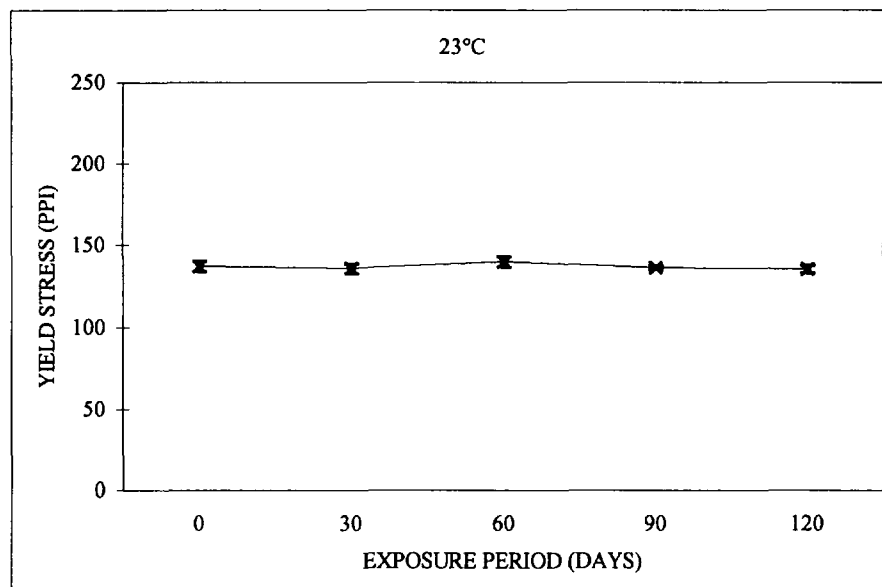
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GL11096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): YIELD STRESS (PPI)
DIRECTION: ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	1	2	3	4	5	Mean	Standard Deviation	Percent Change	1	2	3	4	5	Mean	Standard Deviation	Percent Change	
Control	139.7	138.2	139.7	132.6	135.2	137.1	3.1	0.0	139.7	138.2	139.7	132.6	135.2	137.1	3.1	0.0	
30	139.2	137.2	132.6	134.1		135.8	3.0	-0.9	137.2	135.2	134.1	133.6		135.0	1.6	-1.5	
60	136.3	143.9	140.8	138.4		139.8	3.3	2.0	141.0	143.2	139.5	143.8		141.9	2.0	3.5	
90	136.0	134.7	137.0	137.4		136.3	1.2	-0.6	136.2	138.4	139.3	133.1		136.7	2.7	-0.2	
120	135.0	138.4	132.9	136.0		135.6	2.3	-1.1	138.2	133.2	132.8	139.4		135.9	3.4	-0.9	



Note: Error bars represent one standard deviation at mean sample value.

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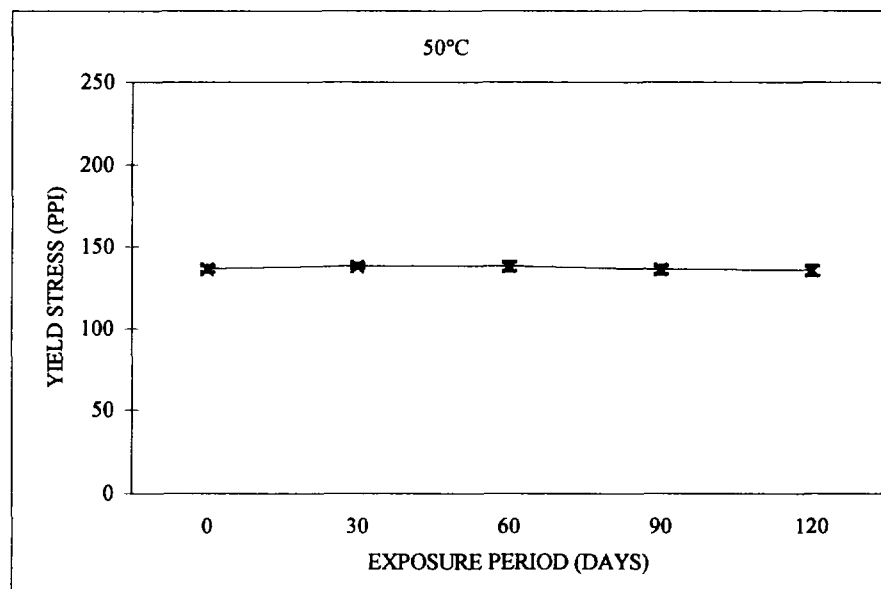
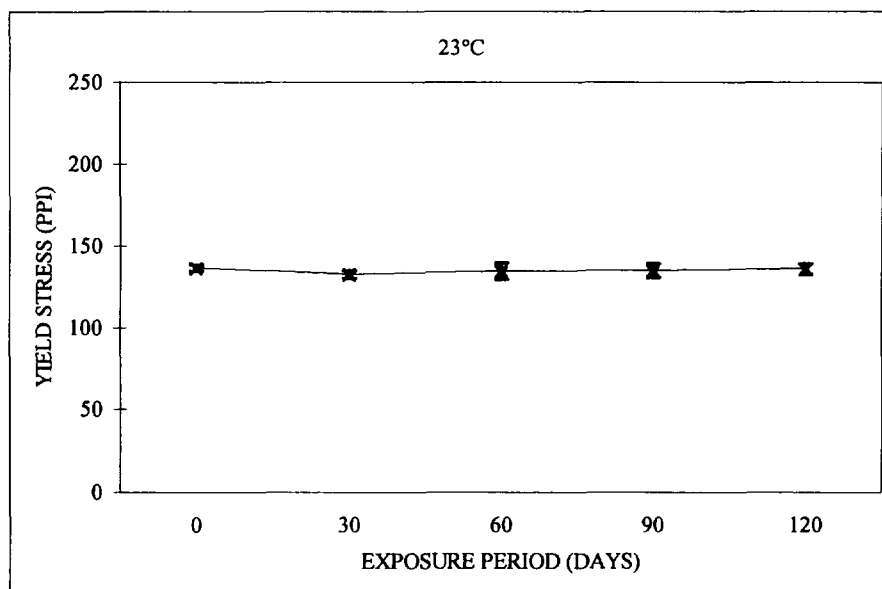
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
 CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
 GEOSYNTEC SAMPLE NO: AL7853
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: ASTM D 638

PROPERTY (UNIT): YIELD STRESS (PPI)
 DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control	139.2	138.7	135.7	135.2	135.7	136.9	1.9	0.0	139.2	138.7	135.7	135.2	135.7	136.9	1.9	0.0			
30	130.1	132.6	133.6	135.7		133.0	2.3	-2.9	140.3	138.7	137.7	137.7		138.6	1.2	1.2			
60	141.0	137.5	130.9	130.4		134.9	5.2	-1.4	141.1	134.7	139.7	138.3		138.5	2.7	1.1			
90	141.5	135.6	131.9	132.9		135.5	4.3	-1.0	140.0	136.2	134.7	134.5		136.4	2.5	-0.4			
120	139.5	138.6	135.0	132.3		136.4	3.3	-0.4	139.2	133.2	137.2	134.1		135.9	2.8	-0.7			



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

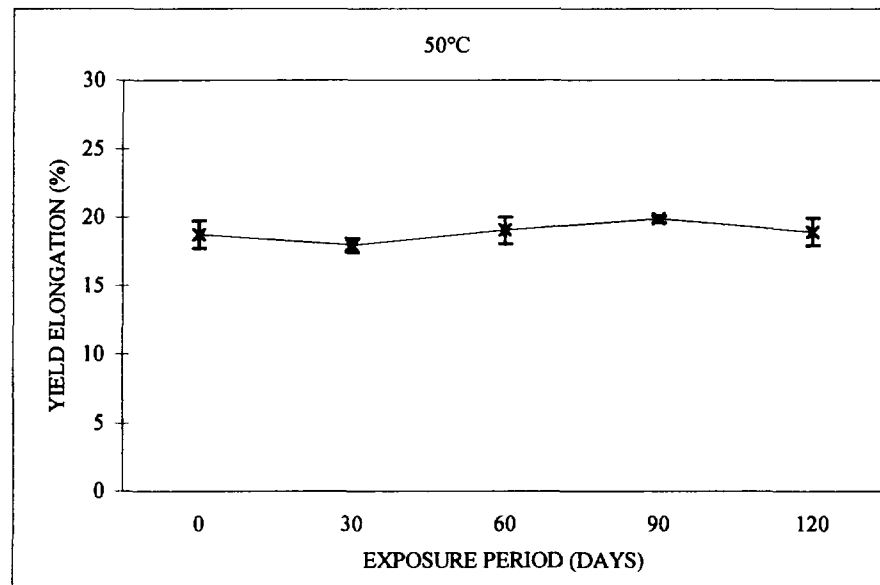
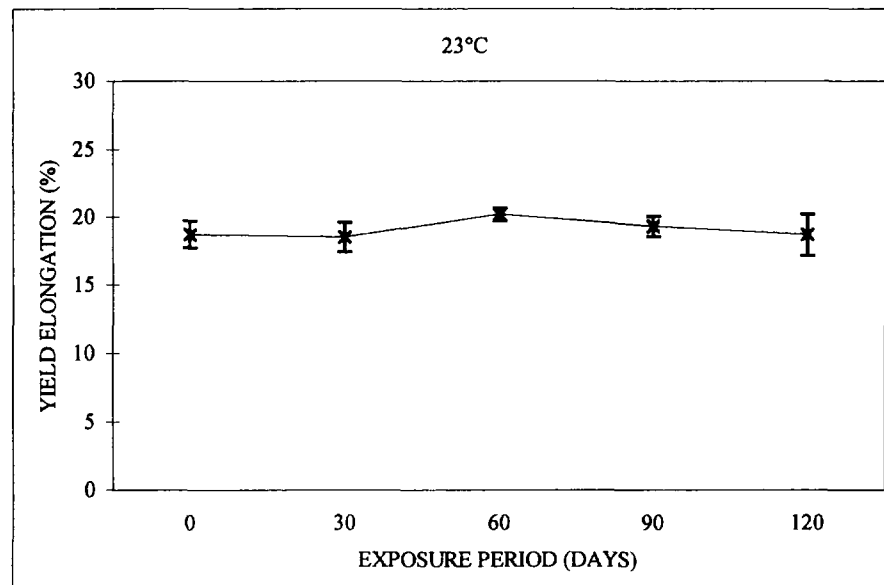
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GL11096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): YIELD ELONGATION (%)
DIRECTION: ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	1	2	3	4	5	Mean	Standard Deviation	Percent Change	1	2	3	4	5	Mean	Standard Deviation	Percent Change	
Control	18.18	18.71	19.80	19.67	17.42	18.76	1.01	0.0	18.18	18.71	19.80	19.67	17.42	18.76	1.01	0.0	
30	18.39	17.36	18.58	19.96		18.57	1.07	-1.0	17.50	17.73	17.95	18.68		17.97	0.51	-4.2	
60	20.78	19.74	19.97	20.51		20.25	0.48	8.0	19.64	18.60	20.15	17.93		19.08	1.00	1.7	
90	19.72	19.74	18.21	19.75		19.36	0.76	3.2	19.88	19.62	20.24	19.88		19.91	0.25	6.1	
120	20.95	17.57	18.06	18.33		18.73	1.51	-0.2	19.97	19.08	19.23	17.57		18.96	1.01	1.1	



Note: Error bars represent one standard deviation at mean sample value.

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CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

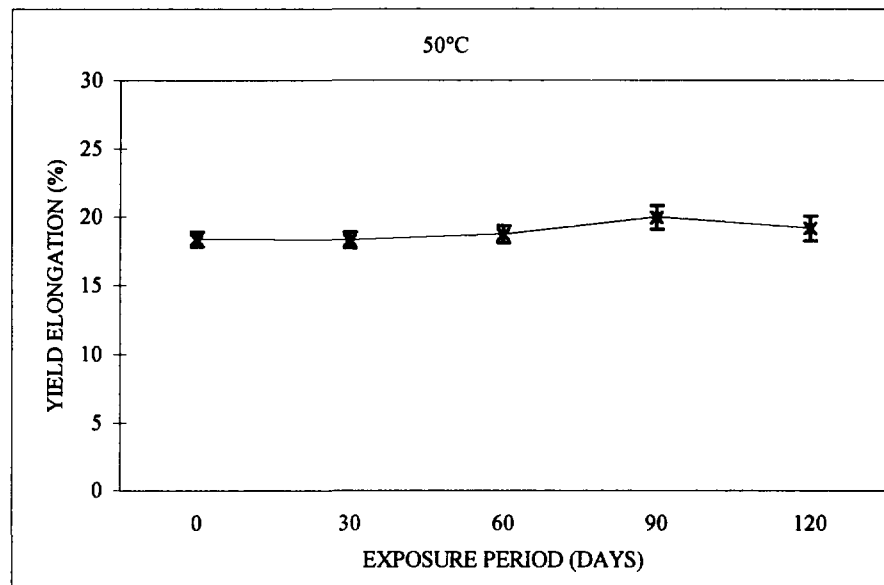
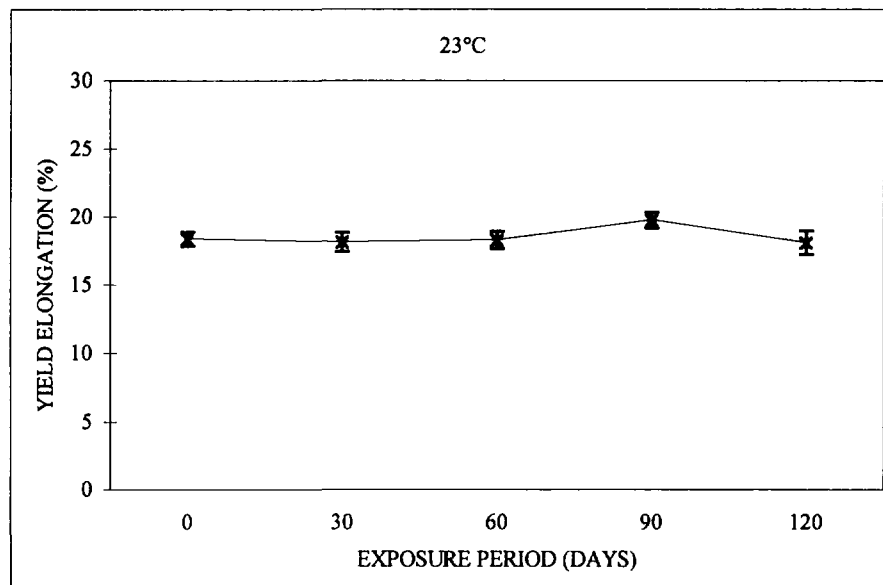
CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): YIELD ELONGATION (%)
DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks				
	Specimens					Standard			Percent			Specimens					Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change							
Control	18.70	18.91	17.98	18.67	17.65	18.38	0.54	0.0	18.70	18.91	17.98	18.67	17.65	18.38	0.54	0.0							
30	19.19	17.74	17.88	17.74		18.14	0.70	-1.3	19.18	18.03	18.39	17.77		18.34	0.61	-0.2							
60	18.08	17.55	19.13	18.47		18.31	0.67	-0.4	18.01	19.59	18.64	18.72		18.74	0.65	1.9							
90	19.11	20.54	19.76	19.74		19.79	0.59	7.6	19.66	18.95	20.81	20.57		20.00	0.86	8.8							
120	18.18	17.40	19.37	17.56		18.13	0.89	-1.4	19.12	20.43	18.22	19.11		19.22	0.91	4.6							



Note: Error bars represent one standard deviation at mean sample value.

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CLIENT: URS GREINER WOODWARD CLYDE
 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTec JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS

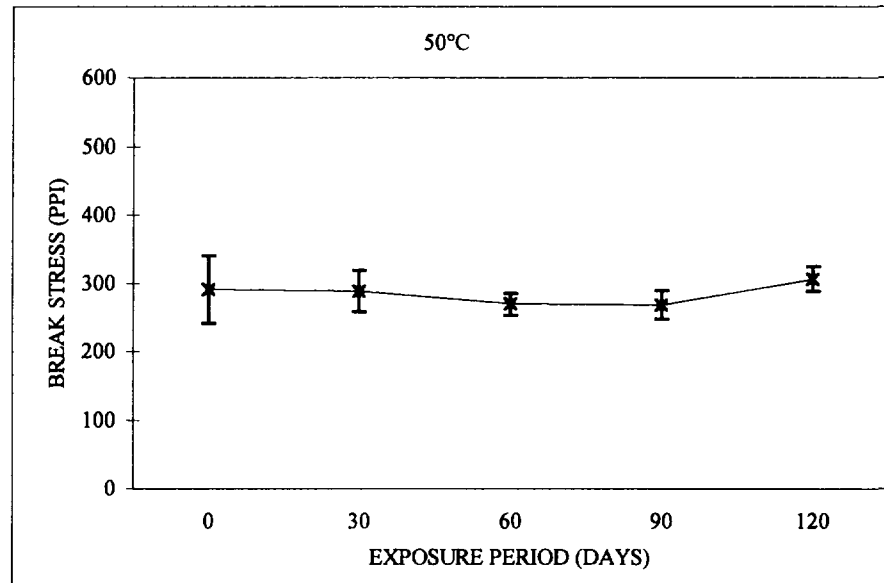
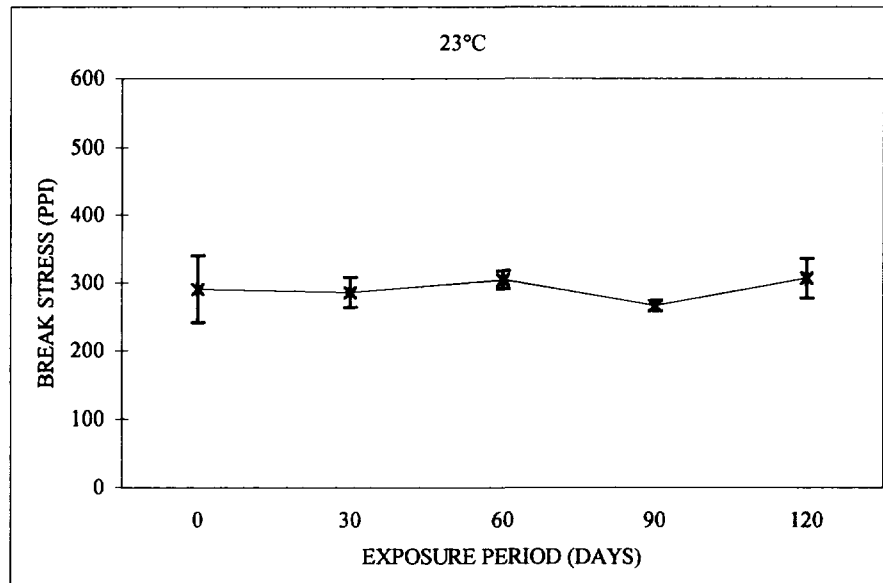
EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
 CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
 GEOSYNTec SAMPLE NO: AL7853
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: ASTM D 638

PROPERTY (UNIT): BREAK STRESS (PPI)

DIRECTION: ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard			Percent Change	Specimens					Standard			Percent Change	
	1	2	3	4	5	Mean	Deviation	1		2	3	4	5	Mean	Deviation				
Control	307.9	279.7	208.9	326.2	330.8	290.7	49.9	0.0	307.9	279.7	208.9	326.2	330.8	290.7	49.9	0.0			
	265.2	302.8	267.3	308.4		285.9	22.9	-1.6	321.2	300.3	283.0	248.0		288.1	31.0	-0.9			
	304.6	324.5	297.0	293.8		305.0	13.8	4.9	265.8	254.4	263.7	293.0		269.2	16.6	-7.4			
	278.8	262.2	261.3	264.1		266.6	8.2	-8.3	255.9	246.1	277.8	292.7		268.1	21.1	-7.8			
	270.4	339.5	298.9	319.8		307.2	29.6	5.7	327.7	292.2	290.3	314.6		306.2	18.1	5.3			



Note: Error bars represent one standard deviation at mean sample value.

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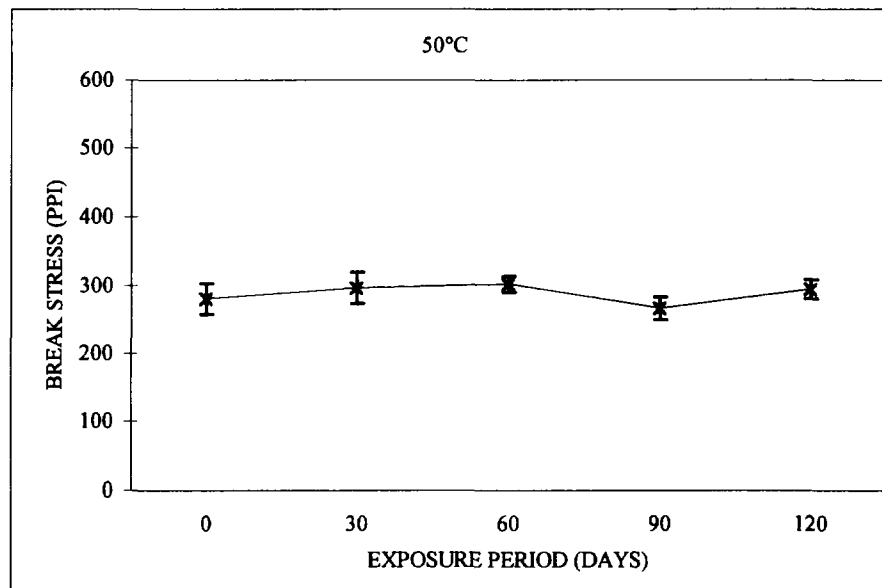
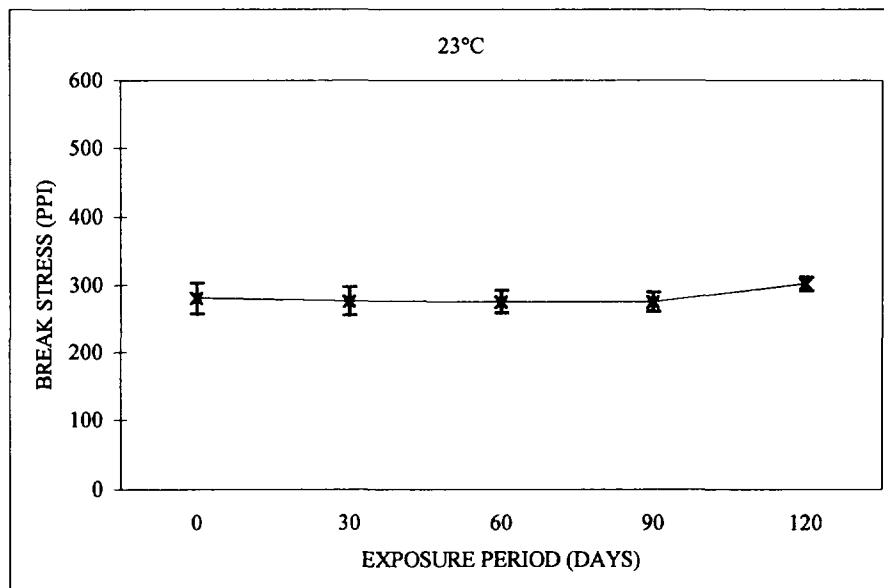
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): BREAK STRESS (PPI)
DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks				
	Specimens					Standard			Percent			Specimens					Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change							
Control	288.1	273.4	316.1	257.6	267.0	280.4	22.8	0.0	288.1	273.4	316.1	257.6	267.0	280.4	22.8	0.0							
30	271.9	277.4	303.9	253.1		276.6	21.0	-1.4	327.2	292.7	270.8	296.2		296.7	23.2	5.8							
60	260.8	294.9	263.8	282.5		275.5	16.1	-1.8	298.9	308.6	286.9	315.3		302.4	12.3	7.8							
90	260.6	277.8	269.1	294.9		275.6	14.7	-1.7	284.4	276.6	246.9	259.2		266.8	16.9	-4.9							
120	287.4	308.0	310.1	303.6		302.3	10.3	7.8	291.8	276.4	303.8	308.5		295.1	14.3	5.2							



Note: Error bars represent one standard deviation at mean sample value.

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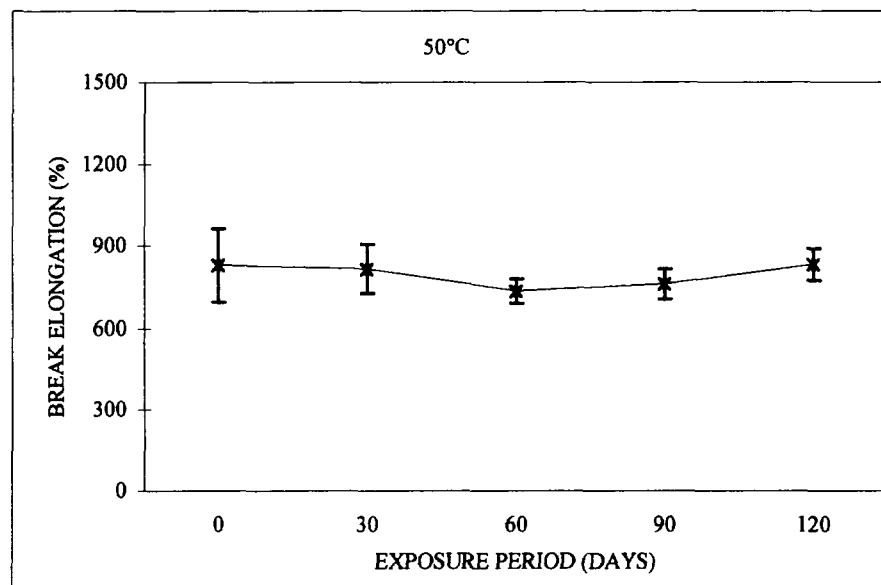
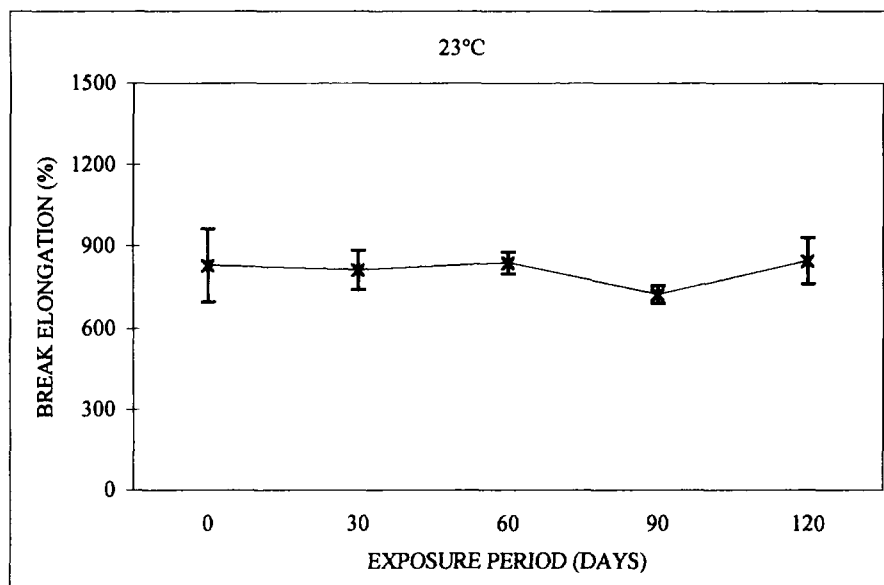
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): BREAK ELONGATION (%)
DIRECTION: ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard			Percent Change	Specimens					Standard			Percent Change	
	1	2	3	4	5	Mean	Deviation	1		2	3	4	5	Mean	Deviation				
Control	871.7	939.0	823.6	602.6	910.7	829.5	134.1	0.0	871.7	939.0	823.6	602.6	910.7	829.5	134.1	0.0			
30	749.0	864.5	751.6	884.3		812.3	72.1	-2.1	914.0	853.2	801.8	701.5		817.6	90.0	-1.4			
60	843.4	894.2	817.0	803.8		839.6	40.0	1.2	726.5	698.2	723.2	800.5		737.1	44.1	-11.1			
90	768.8	696.2	705.4	724.6		723.7	32.3	-12.7	732.5	704.8	784.6	828.2		762.5	54.9	-8.1			
120	736.4	825.5	892.8	927.2		845.5	84.1	1.9	910.7	788.6	787.3	841.4		832.0	58.2	0.3			



Notes:

1. Break elongation values are calculated based on a gauge length of 50 mm (1.97 in.)
2. Error bars represent one standard deviation at mean sample value.

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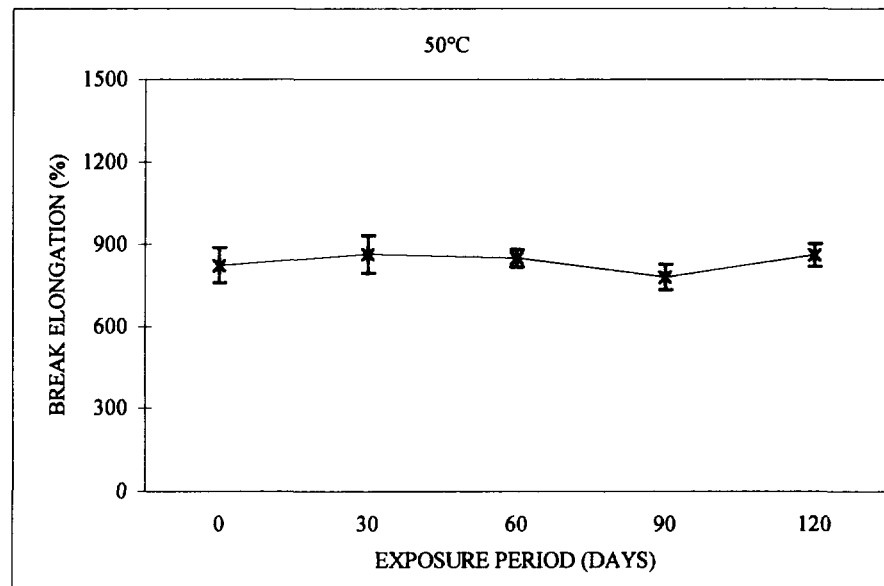
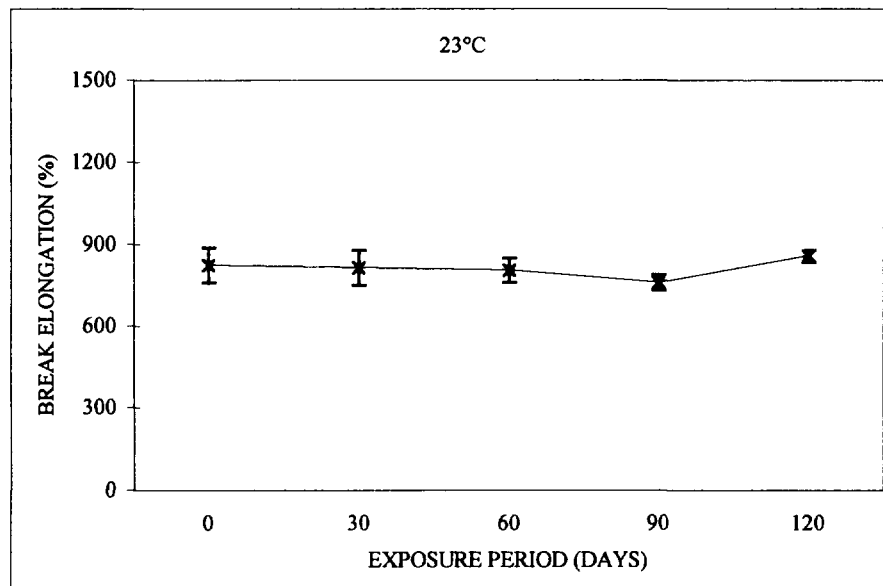
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): BREAK ELONGATION (%)
DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks				
	Specimens					Standard			Percent			Specimens					Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change							
Control	840.1	810.4	926.5	764.2	778.7	823.9	64.4	0.0	840.1	810.4	926.5	764.2	778.7	823.9	64.4	0.0							
30	797.2	818.9	899.4	745.0		815.1	64.2	-1.1	956.9	850.6	790.6	861.8		865.0	68.8	5.0							
60	762.2	859.2	777.4	828.2		806.7	44.9	-2.1	841.4	860.5	811.7	890.9		851.1	33.3	3.3							
90	737.8	773.4	737.8	797.2		761.5	29.1	-7.6	824.9	817.0	730.5	755.6		782.0	46.2	-5.1							
120	827.5	865.8	877.0	869.1		859.8	22.1	4.4	845.3	813.7	892.2	901.4		863.1	41.1	4.8							



Notes:
 1. Break elongation values are calculated based on a gauge length of 50 mm (1.97 in.)
 2. Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

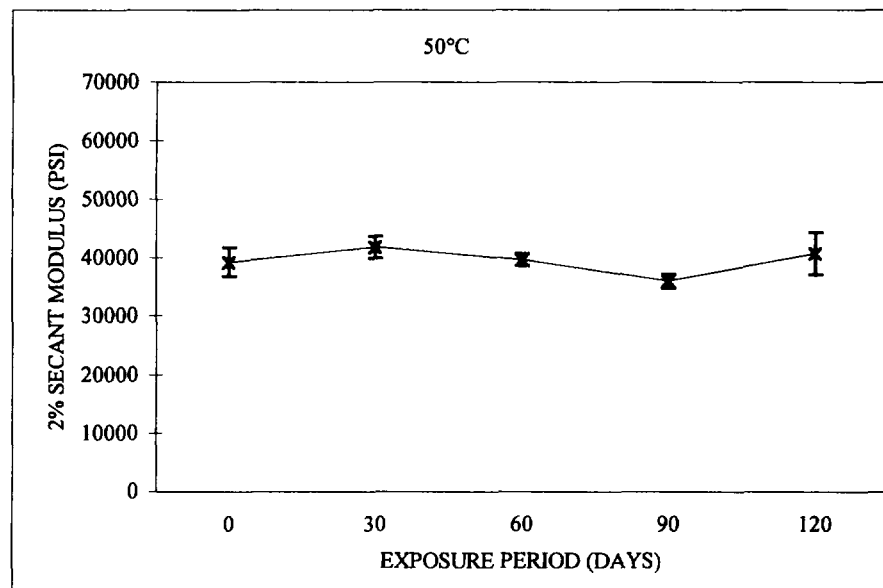
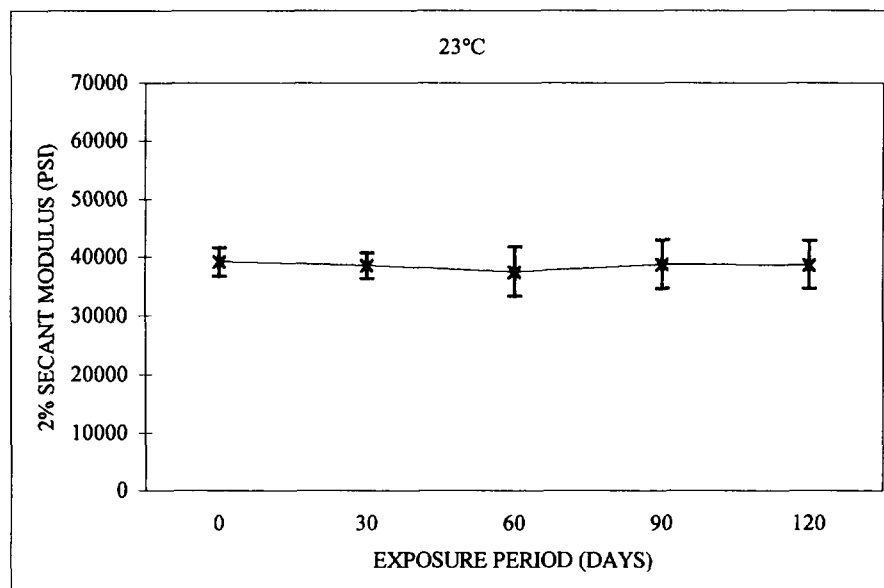
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): 2% SECANT MODULUS ⁽¹⁾ (PSI)

DIRECTION: ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	1	2	3	4	5	Mean	Standard Deviation	Percent Change	1	2	3	4	5	Mean	Standard Deviation	Percent Change	
Control	40350	37060	39090	42760	36840	39220	2457.4	0.0	40350	37060	39090	42760	36840	39220	2457.4	0.0	
30	40620	40360	36740	36600		38580	2208.8	-1.6	42700	41710	43620	39320		41838	1850.7	6.7	
60	36530	36450	33640	43500		37530	4200.8	-4.3	38800	40030	40950	38840		39655	1034.9	1.1	
90	37190	39730	44160	34390		38868	4148.0	-0.9	37270	36900	34960	35100		36058	1197.4	-8.1	
120	36240	39960	44050	34840		38773	4128.8	-1.1	36970	38500	42740	44670		40720	3590.4	3.8	



- Notes:
1. 2% secant modulus values are calculated based on the total cross-head displacement and a gauge length of 33 mm (1.3 in.).
 2. Error bars represent one standard deviation at mean sample value.

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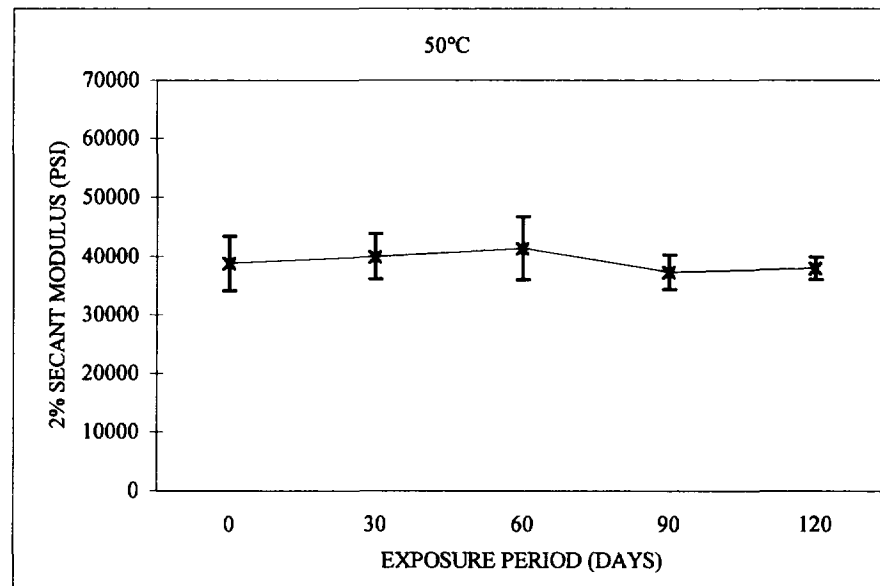
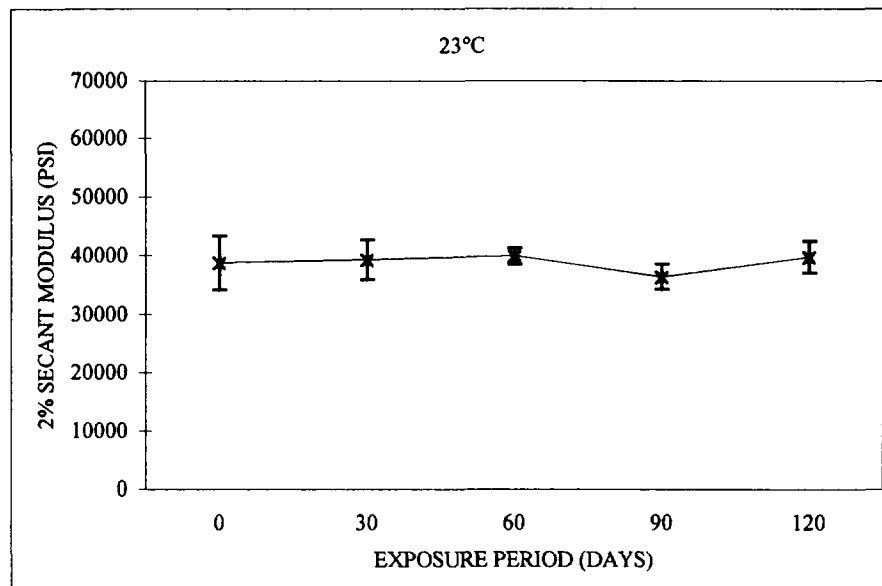
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 638

PROPERTY (UNIT): 2% SECANT MODULUS ⁽¹⁾ (PSI)
DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	1	2	3	4	5	Mean	Standard Deviation	Percent Change	1	2	3	4	5	Mean	Standard Deviation	Percent Change	
Control	41390	39960	42760	30950	39080	38828	4621.5	0.0	41390	39960	42760	30950	39080	38828	4621.5	0.0	
30	34350	41390	40190	41490		39355	3388.5	1.4	35130	40040	40160	44670		40000	3896.7	3.0	
60	40160	37970	40650	41370		40038	1465.2	3.1	37170	36580	44220	47370		41335	5313.6	6.5	
90	36160	39380	34330	35920		36448	2116.9	-6.1	37710	38990	39590	33110		37350	2933.4	-3.8	
120	43130	37130	40760	38420		39860	2647.6	2.7	38940	40240	36450	36390		38005	1905.8	-2.1	



- Notes:**
1. 2% secant modulus values are calculated based on the total cross-head displacement and a gauge length of 33 mm (1.3 in.).
 2. Error bars represent one standard deviation at mean sample value.

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CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS

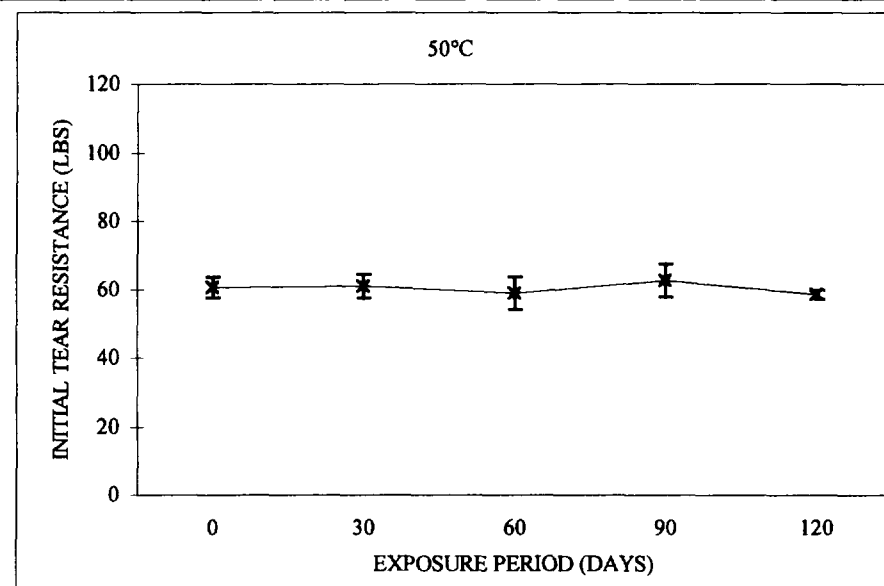
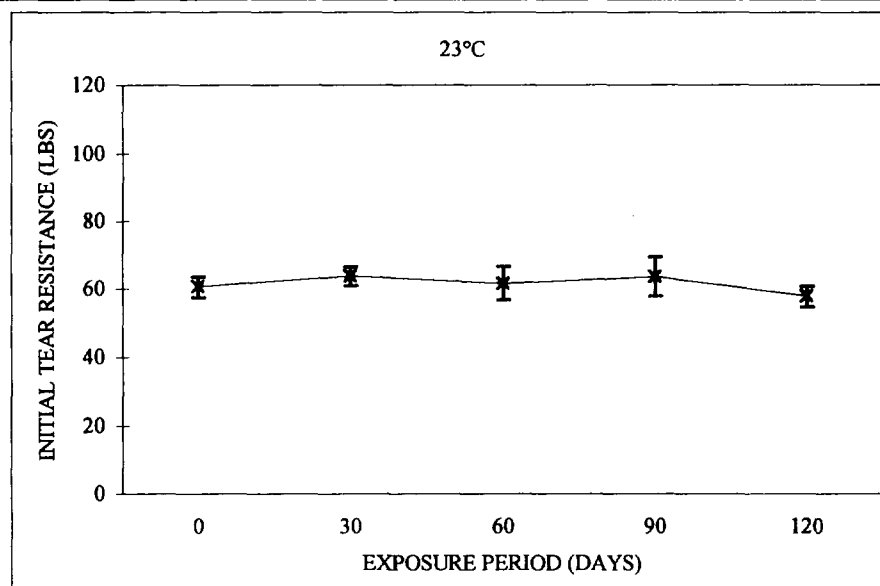
EPA METHOD 9090

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 1004

PROPERTY (UNIT): INITIAL TEAR RESISTANCE (LBS)

DIRECTION: ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard			Percent Change	Specimens					Standard			Percent Change	
	1	2	3	4	5	Mean	Deviation			1	2	3	4	5	Mean	Deviation			
Control																			
	62.0	63.1	59.3	56.0	63.3	60.7	3.1	0.0	62.0	63.1	59.3	56.0	63.3	60.7	3.1	0.0			
	64.5	60.5	63.3	67.4		63.9	2.9	5.2	62.7	65.2	57.1	59.2		61.1	3.6	0.5			
	65.5	65.7	55.2	60.5		61.7	5.0	1.6	59.4	61.6	51.9	62.9		59.0	4.9	-2.9			
	61.2	66.9	69.9	56.8		63.7	5.8	4.9	57.5	66.2	67.5	59.9		62.8	4.8	3.4			
	62.2	55.6	57.9	55.8		57.9	3.1	-4.7	56.6	59.1	59.1	59.6		58.6	1.4	-3.5			



Note: Error bars represent one standard deviation at mean sample value.

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Reviewed by: Date: 12/26/00
Cuneyt Gokmen, Program Manager



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CHEMICAL COMPATIBILITY TEST RESULTS

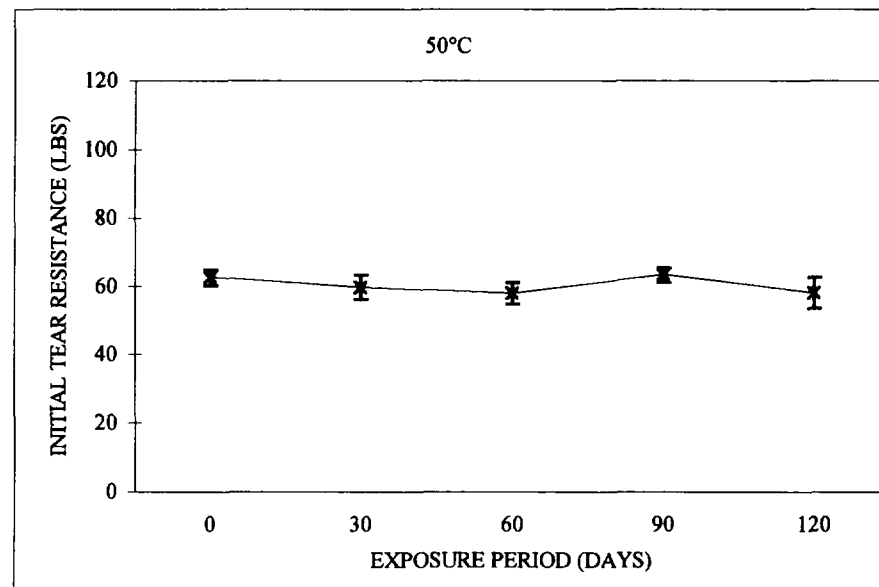
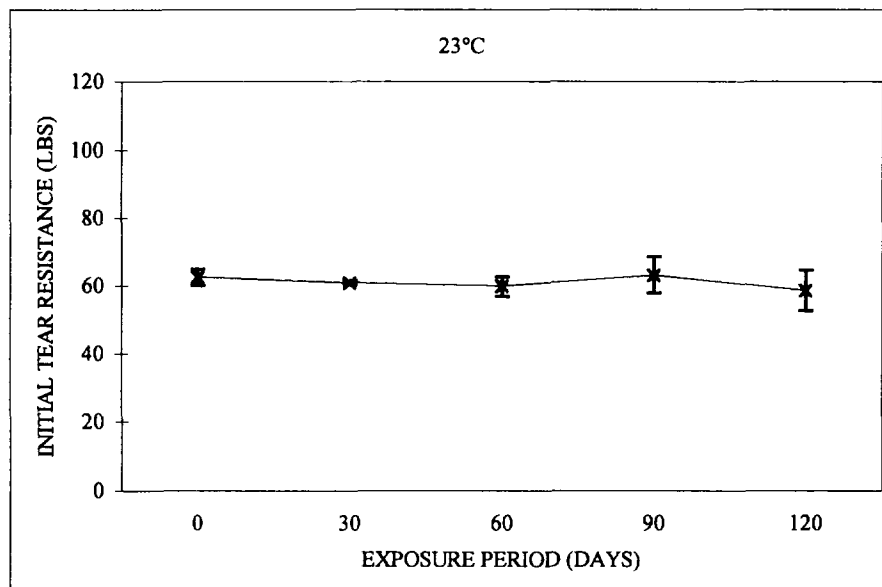
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 1004

PROPERTY (UNIT): INITIAL TEAR RESISTANCE (LBS)
DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control	59.7	61.2	62.5	63.8	65.9	62.6	2.4	0.0	59.7	61.2	62.5	63.8	65.9	62.6	2.4	0.0			
	61.6	60.6	61.5	60.3		61.0	0.6	-2.6	62.9	62.1	58.8	55.0		59.7	3.6	-4.7			
	59.9	56.3	60.1	63.4		59.9	2.9	-4.3	57.2	62.7	55.4	56.8		58.0	3.2	-7.3			
	63.8	70.5	58.6	60.2		63.3	5.3	1.0	65.0	63.0	60.5	65.1		63.4	2.2	1.2			
	55.0	67.5	57.0	55.1		58.7	6.0	-6.3	54.9	64.0	54.3	59.5		58.2	4.5	-7.1			



- Notes:
1. Break elongation values are calculated based on a gauge length of 50 mm (1.97 in.)
 2. Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

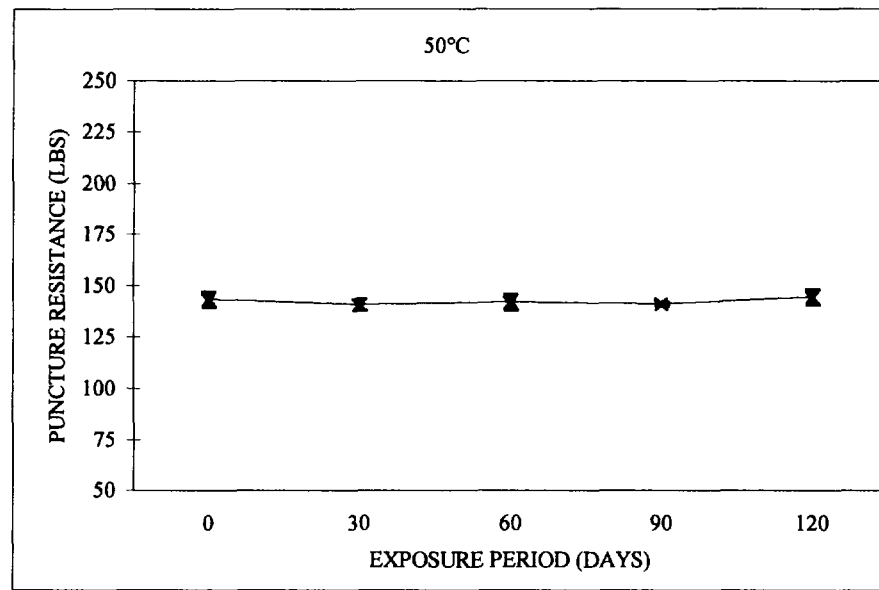
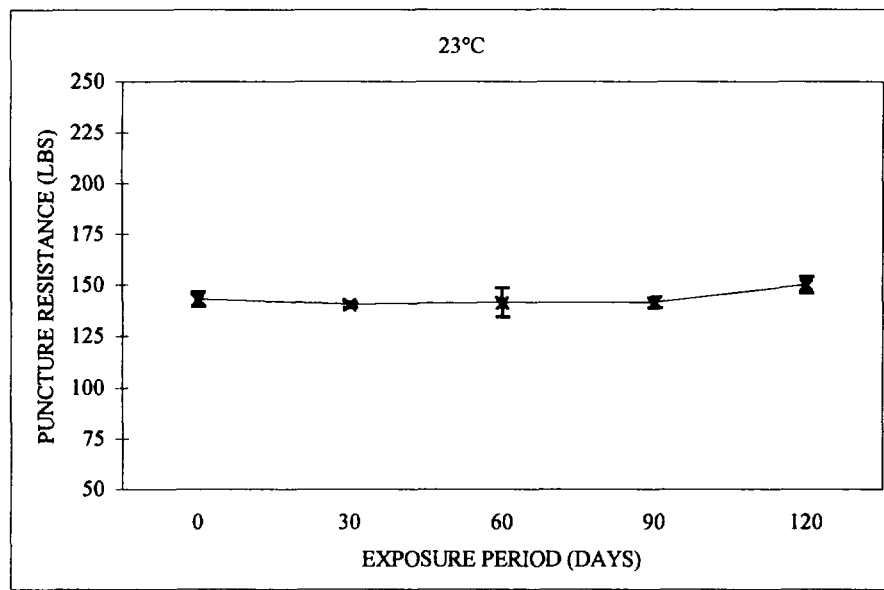
CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTEC SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 4833

PROPERTY (UNIT): INDEX PUNCTURE RESISTANCE (LBS)

DIRECTION: N/A

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard Percent				Specimens					Standard Percent				
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change			
Control	147.2	146.3	143.5	138.4	140.9	143.26	3.67	0.0	147.2	146.3	143.5	138.4	140.9	143.26	3.67	0.0			
30	138.7	141.1	141.8	140.5		140.53	1.33	-1.9	140.3	144.5	137.6	140.6		140.75	2.84	-1.8			
60	132.1	140.2	146.3	147.7		141.58	7.11	-1.2	146.8	141.8	141.6	137.5		141.93	3.81	-0.9			
90	142.7	138.4	144.5	141.1		141.68	2.59	-1.1	141.5	141.8	139.7	141.4		141.10	0.95	-1.5			
120	155.9	150.7	148.4	146.3		150.33	4.13	4.9	147.5	143.2	147.7	139.7		144.53	3.83	0.9			



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

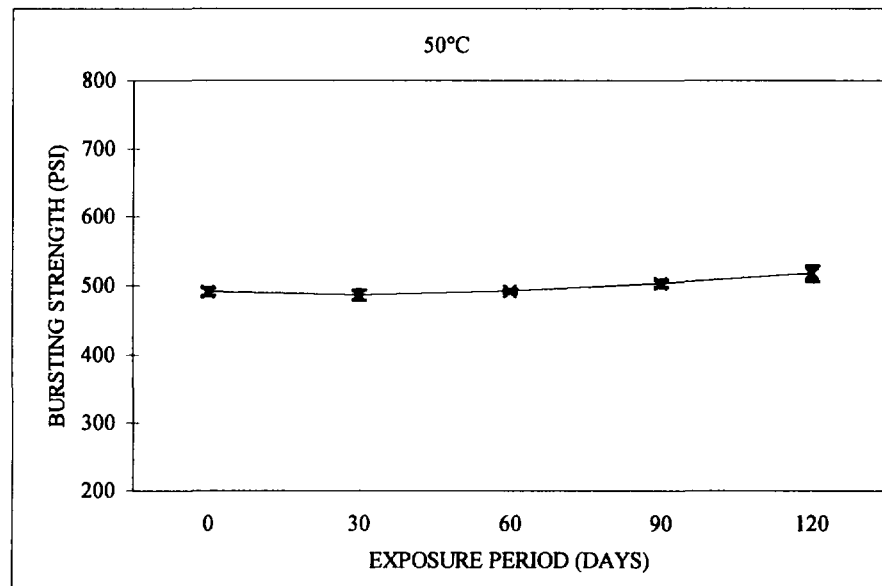
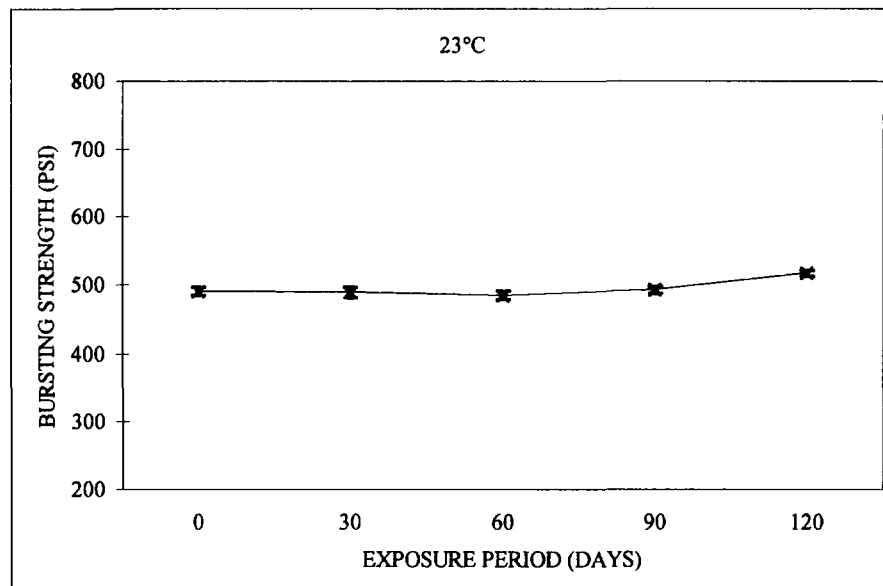
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

MATERIAL TYPE: 60 MIL HDPE SMOOTH GEOMEMBRANE
CLIENT SAMPLE ID: GSE 60 MIL HYPERFLEX
GEOSYNTec SAMPLE NO: AL7853
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 3786

PROPERTY (UNIT): HYDRAULIC BURSTING STRENGTH (PSI)
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Standard			Specimens					Standard			
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change	
Control	501	489	490	486	489	491.0	5.8	0.0	501	489	490	486	489	491.0	5.8	0.0	
30	483	482	494	498		489.3	8.0	-0.4	488	485	478	495		486.5	7.0	-0.9	
60	494	480	485	482		485.3	6.2	-1.2	495	489	491	493		492.0	2.6	0.2	
90	497	498	489	488		493.0	5.2	0.4	510	504	501	497		503.0	5.5	2.4	
120	518	518	512	522		517.5	4.1	5.4	519	529	502	521		518	11.4	5.4	



Note: Error bars represent one standard deviation at mean sample value.

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GEOTEXTILE



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CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS

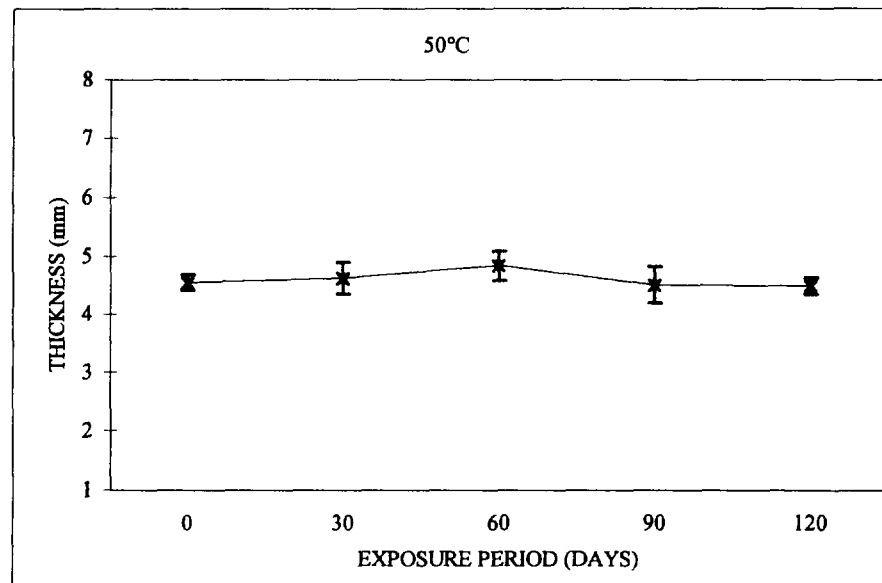
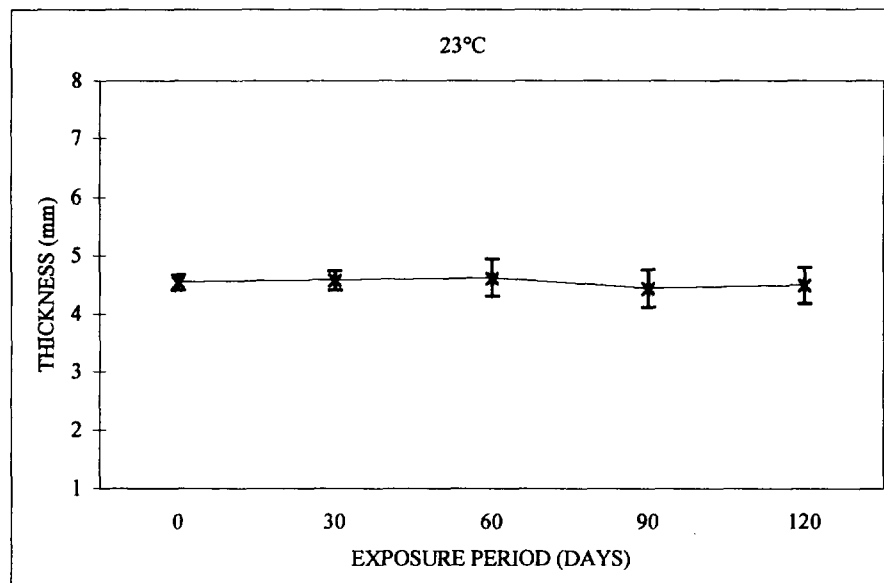
EPA METHOD 9090

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
GEOSYNTec SAMPLE NO: AL7890
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 5199

PROPERTY (UNIT): THICKNESS (mm)

DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks							
	Specimens					Standard			Percent			Specimens						Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change		1	2	3	4	5	Mean	Deviation
Control	4.58	4.41	4.73	4.49		4.55	0.14	0.0	4.58	4.41	4.73	4.49		4.55	0.14	0.0								
30	4.60	4.82	4.48	4.43		4.58	0.17	0.7	4.51	5.01	4.62	4.38		4.63	0.27	1.7								
60	4.85	4.22	4.51	4.92		4.63	0.32	1.6	4.82	5.00	4.49	5.04		4.84	0.25	6.3								
90	4.48	4.02	4.46	4.81		4.44	0.32	-2.4	4.80	4.11	4.42	4.71		4.51	0.31	-0.9								
120	4.14	4.38	4.87	4.59		4.50	0.31	-1.3	4.31	4.65	4.54	4.47		4.49	0.14	-1.3								



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

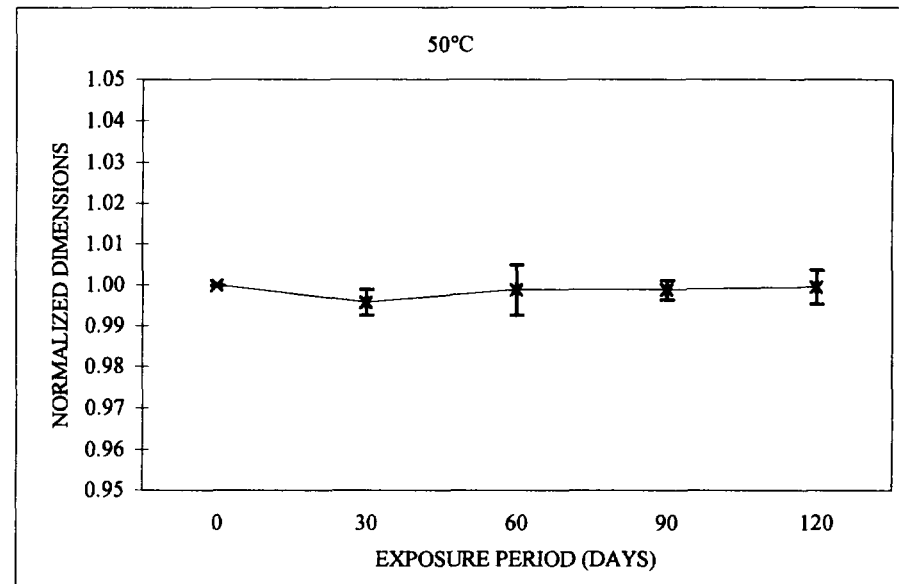
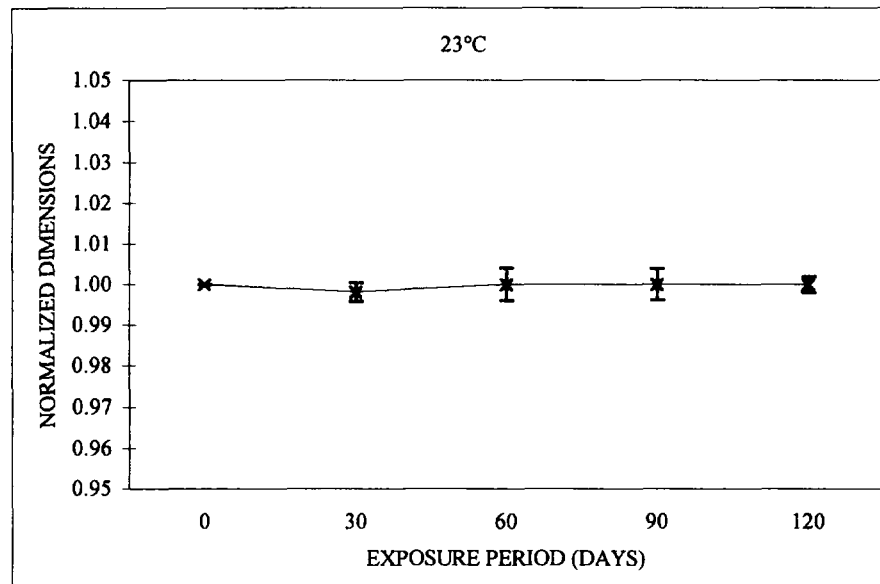
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
 CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
 GEOSYNTEC SAMPLE NO: AL7890
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: EPA 9090

PROPERTY (UNIT): NORMALIZED DIMENSIONS (FINAL LENGTH/INITIAL LENGTH)
 DIRECTION: ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Mean	Standard Deviation	Percent Change	Specimens					Mean	Standard Deviation	Percent Change	
	1	2	3	4	5				1	2	3	4	5				
Control																	
	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	
	1.0000	0.9951	1.0000	0.9975		0.9982	0.0024	-0.19	0.9951	0.9951	1.0000	0.9927		0.9957	0.0031	-0.43	
	1.0000	1.0050	0.9951	1.0000		1.0000	0.0040	0.00	0.9901	1.0000	1.0000	1.0049		0.9988	0.0062	-0.12	
	1.0000	0.9951	1.0000	1.0049		1.0000	0.0040	0.00	1.0000	1.0000	1.0000	0.9951		0.9988	0.0025	-0.12	
	1.0000	1.0000	1.0025	0.9976		1.0000	0.0020	0.00	1.0049	1.0000	0.9951	0.9976		0.9994	0.0042	-0.06	



Note: Error bars represent one standard deviation at mean sample value.

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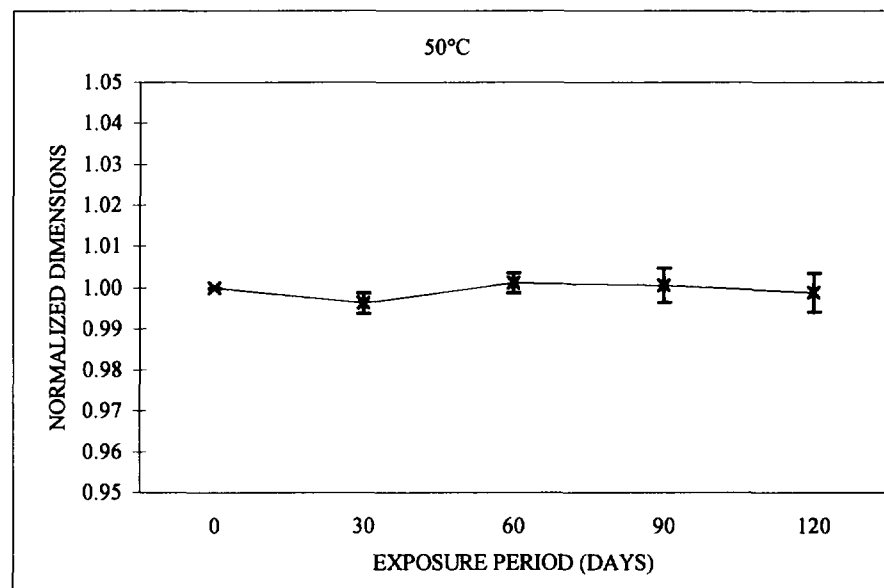
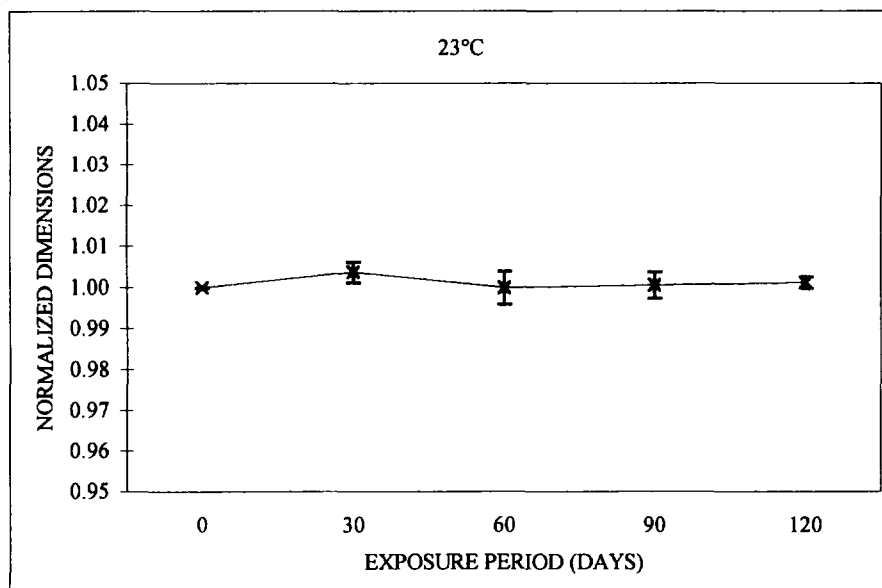
CLIENT: URS GREINER WOODWARD CLYDE
 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTEC JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
 CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
 GEOSYNTEC SAMPLE NO: AL7890
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: EPA 9090

PROPERTY (UNIT): NORMALIZED DIMENSIONS (FINAL LENGTH/INITIAL LENGTH)
 DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Standard Percent			Specimens					Standard Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change	
Control	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	1.0000	1.0000	1.0000	1.0000		1.0000	0.0000	0.00	
	1.0050	1.0050	1.0000	1.0049		1.0037	0.0025	0.37	1.0000	0.9951	0.9951	0.9951		0.9963	0.0025	-0.37	
	1.0000	1.0000	1.0049	0.9951		1.0000	0.0040	0.00	1.0000	1.0049	1.0000	1.0000		1.0012	0.0024	0.12	
	1.0000	0.9976	1.0049	1.0000		1.0006	0.0031	0.06	0.9951	1.0049	1.0000	1.0024		1.0006	0.0042	0.06	
	1.0025	1.0000	1.0025	1.0000		1.0012	0.0014	0.12	1.0000	0.9952	0.9951	1.0049		0.9988	0.0047	-0.12	



Note: Error bars represent one standard deviation at mean sample value.

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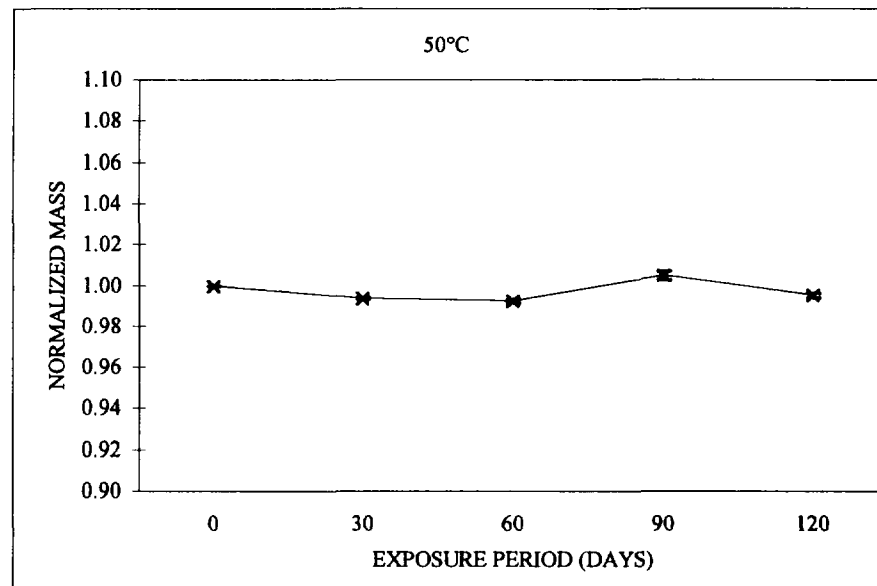
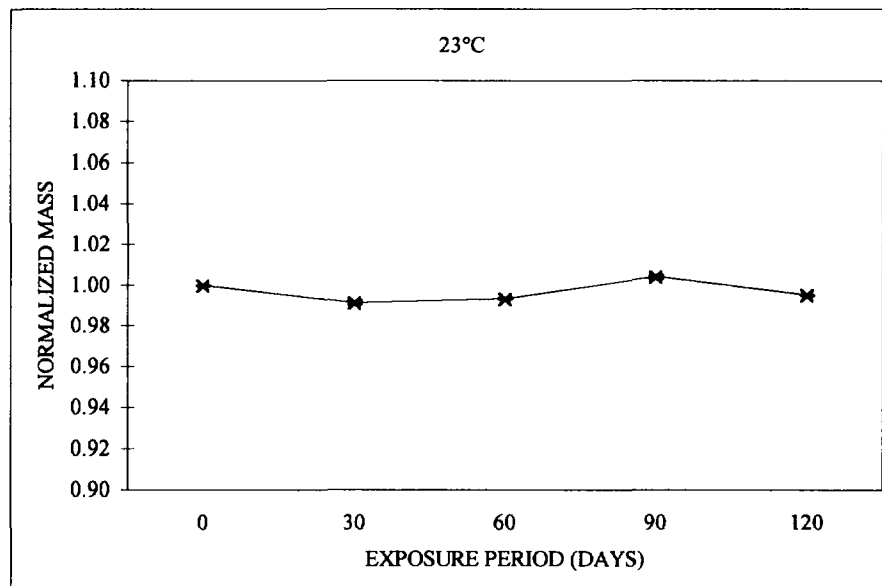
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
GEOSYNTEC SAMPLE NO: AL7890
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: EPA 9090

PROPERTY (UNIT): NORMALIZED MASS (FINAL MASS/INITIAL MASS)
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Standard Percent			Specimens					Standard Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change	
Control	1.0000	1.0000				1.0000	0.0000	0.00	1.0000	1.0000				1.0000	0.0000	0.00	
30	0.9911	0.9923				0.9917	0.0008	-0.83	0.9936	0.9942				0.9939	0.0004	-0.61	
60	0.9934	0.9938				0.9936	0.0003	-0.64	0.9933	0.9920				0.9927	0.0010	-0.73	
90	1.0036	1.0049				1.0042	0.0009	0.42	1.0035	1.0066				1.0051	0.0022	0.51	
120	0.9952	0.9953				0.9952	0.0000	-0.48	0.9961	0.9946				0.9953	0.0011	-0.47	



Note: Error bars represent one standard deviation at mean sample value.

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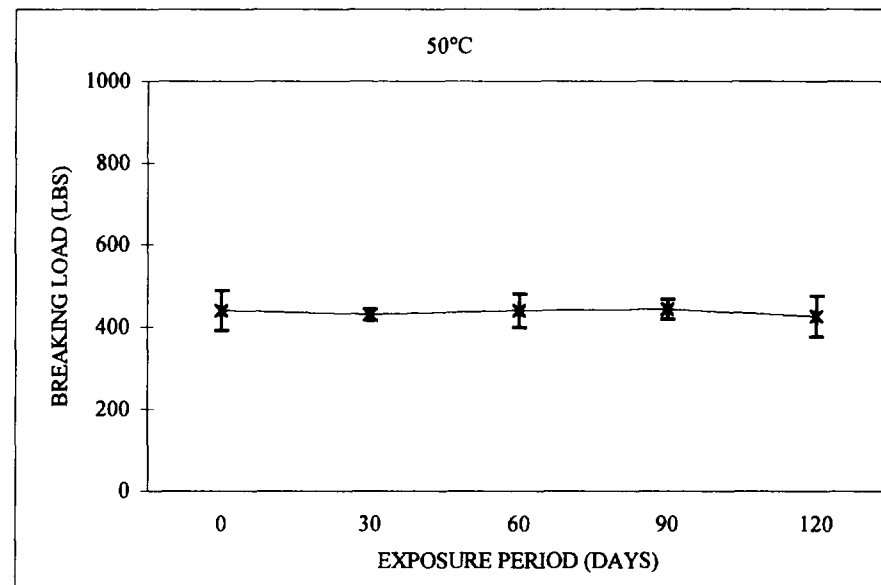
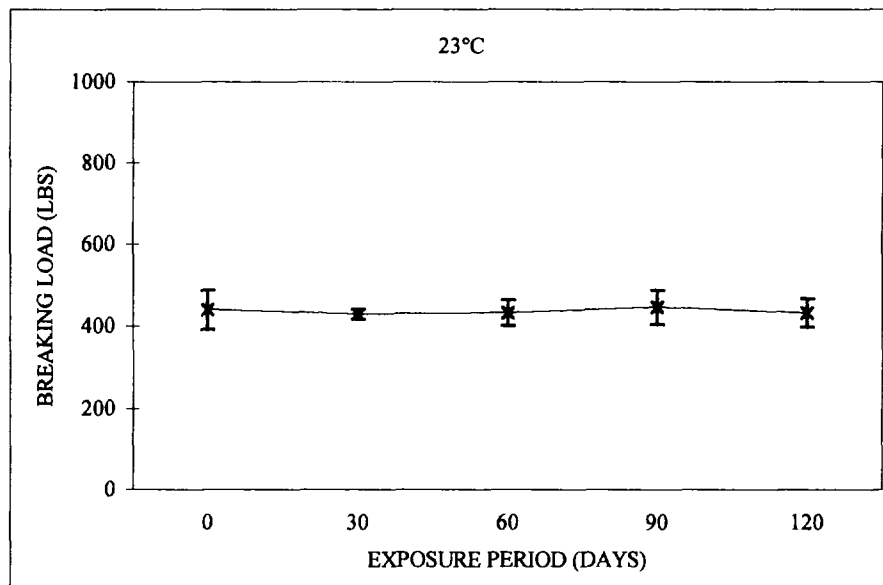
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
GEOSYNTEC SAMPLE NO: AL7890
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 4632

PROPERTY (UNIT): GRAB BREAKING LOAD (LBS)
DIRECTION: ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control	470.2	392.7	384.5	460.2	492.0	439.9	48.3	0.0	470.2	392.7	384.5	460.2	492.0	439.9	48.3	0.0			
30	422.0	424.5	444.7			430.4	12.4	-2.2	429.0	445.5	418.7			431.1	13.5	-2.0			
60	399.7	436.1	462.4			432.7	31.5	-1.6	408.5	425.2	485.5			439.7	40.5	0.0			
90	412.7	432.4	493.2			446.1	42.0	1.4	447.9	465.6	417.6			443.7	24.3	0.9			
120	473.1	412.7	413.4			433.1	34.7	-1.6	412.8	480.9	385.4			426.4	49.2	-3.1			



Note: Error bars represent one standard deviation at mean sample value.

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CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS

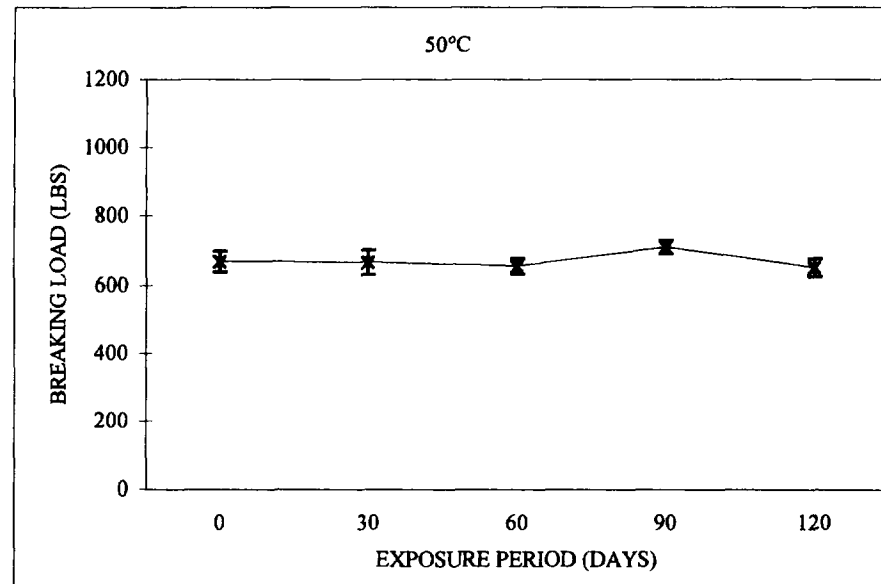
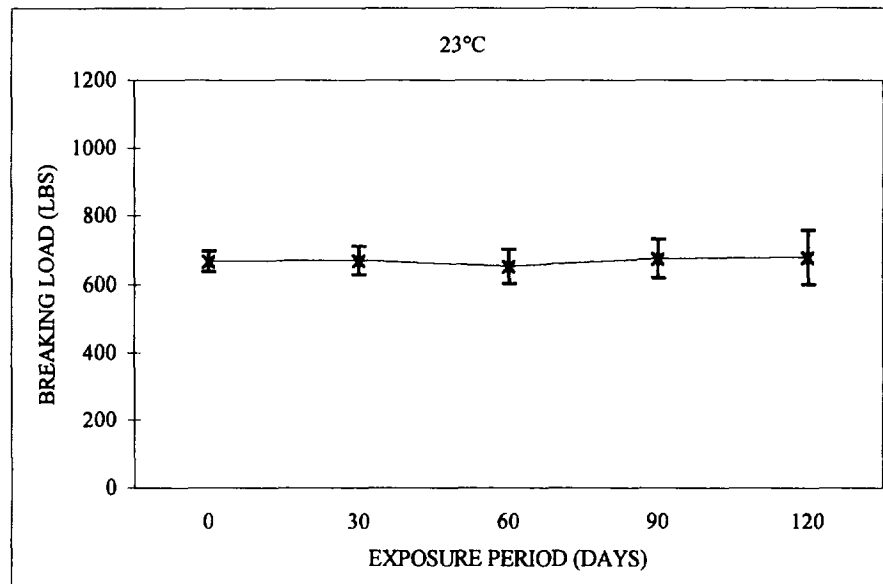
EPA METHOD 9090

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
GEOSYNTEC SAMPLE NO: AL7890
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 4632

PROPERTY (UNIT): GRAB BREAKING LOAD (LBS)

DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard			Percent Change	Specimens					Standard			Percent Change	
	1	2	3	4	5	Mean	Deviation			1	2	3	4	5	Mean	Deviation			
Control	679.7	673.7	679.0	618.0	698.5	669.8	30.4	0.0		679.7	673.7	679.0	618.0	698.5	669.8	30.4	0.0		
30	716.0	637.0	661.0			671.3	40.5	0.2		633.7	667.2	703.5			668.1	34.9	-0.2		
60	613.7	709.2	638.0			653.6	49.6	-2.4		680.7	652.5	636.7			656.6	22.3	-2.0		
90	632.8	656.2	740.8			676.6	56.8	1.0		690.4	728.8	715.4			711.5	19.5	6.2		
120	589.2	729.0	723.4			680.5	79.1	1.6		682.7	645.9	630.4			653.0	26.9	-2.5		



Note: Error bars represent one standard deviation at mean sample value.

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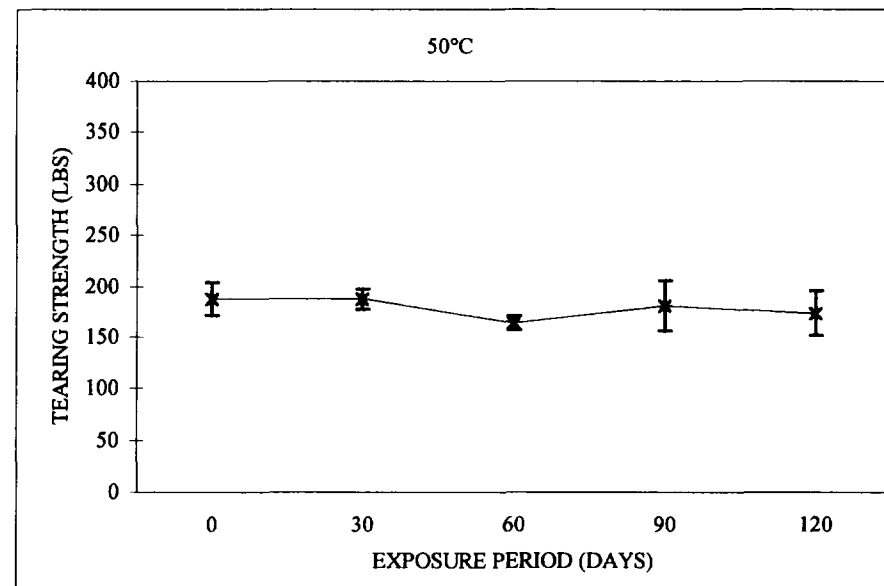
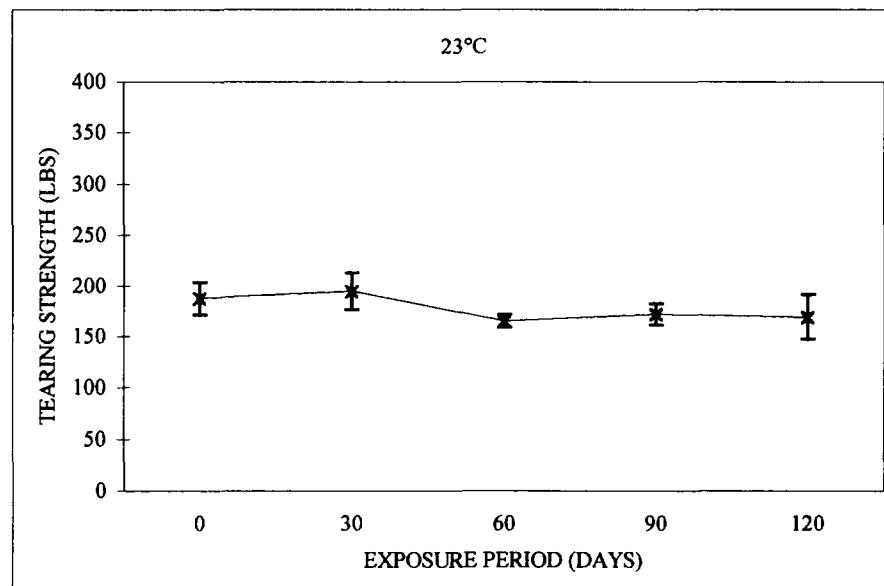
CLIENT: URS GREINER WOODWARD CLYDE
 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTEC JOB NO: GLI1096

CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
 CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
 GEOSYNTEC SAMPLE NO: AL7890
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: ASTM D 4533

PROPERTY (UNIT): TRAPEZOID TEARING STRENGTH (LBS)
 DIRECTION: ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control	174.2	184.0	210.0	198.7	172.5	187.9	16.2	0.0	174.2	184.0	210.0	198.7	172.5	187.9	16.2	0.0			
30	187.1	215.5	182.5			195.0	17.9	3.8	197.1	189.6	177.1			187.9	10.1	0.0			
60	168.2	158.5	170.7			165.8	6.4	-11.8	172.2	158.5	162.5			164.4	7.0	-12.5			
90	164.2	184.5	169.0			172.6	10.6	-8.2	200.5	190.2	153.2			181.3	24.9	-3.5			
120	173.5	189.4	146.1			169.7	21.9	-9.7	188.0	185.0	148.1			173.7	22.2	-7.5			



Note: Error bars represent one standard deviation at mean sample value.

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CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTec JOB NO: GLI1096

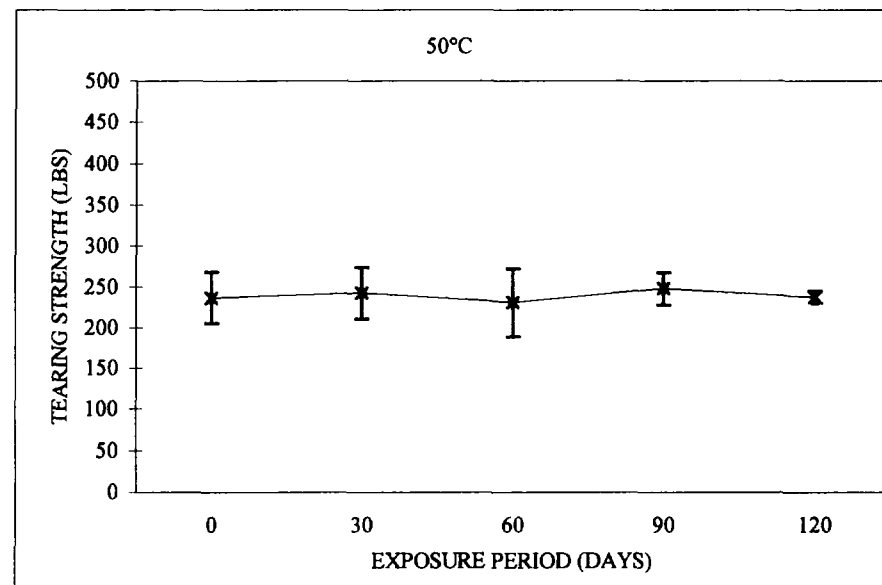
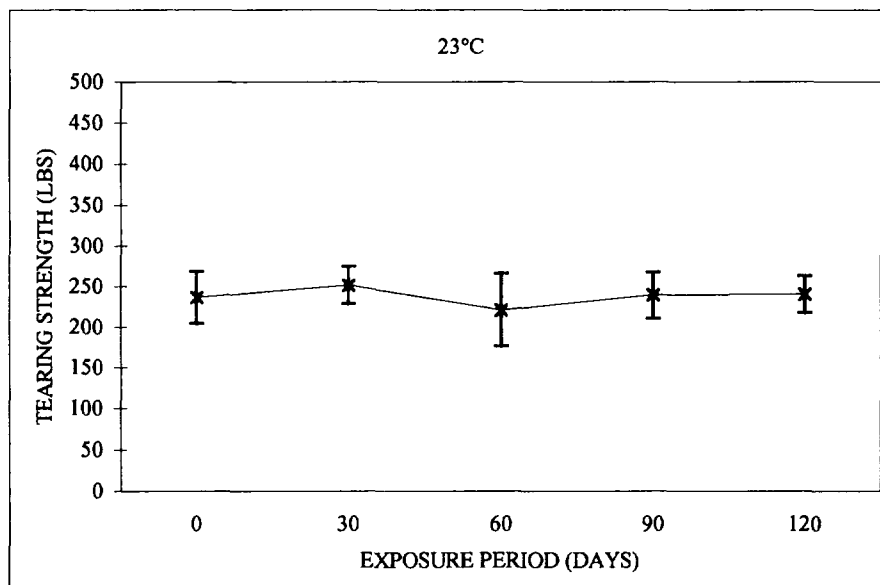
CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
GEOSYNTec SAMPLE NO: AL7890
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 4533

PROPERTY (UNIT): TRAPEZOID TEARING STRENGTH (LBS)
DIRECTION: CROSS-ROLL

Exposure Period (Days)	23°C									50°C									Remarks
	Specimens					Standard				Specimens					Standard				
	1	2	3	4	5	Mean	Deviation	Percent Change	1	2	3	4	5	Mean	Deviation	Percent Change			
Control																			
	207.0	262.5	233.0	205.6	275.6	236.7	31.8	0.0	207.0	262.5	233.0	205.6	275.6	236.7	31.8	0.0			
	225.5	265.8	264.3			251.9	22.8	6.4	238.3	213.1	275.5			242.3	31.4	2.3			
	270.0	212.2	181.7			221.3	44.8	-6.5	190.0	273.0	229.5			230.8	41.5	-2.5			
	233.3	214.5	270.7			239.5	28.6	1.2	262.6	255.7	224.8			247.7	20.1	4.6			
	239.8	264.0	218.0			240.6	23.0	1.6	241.2	242.6	228.8			237.5	7.6	0.3			



Note: Error bars represent one standard deviation at mean sample value.

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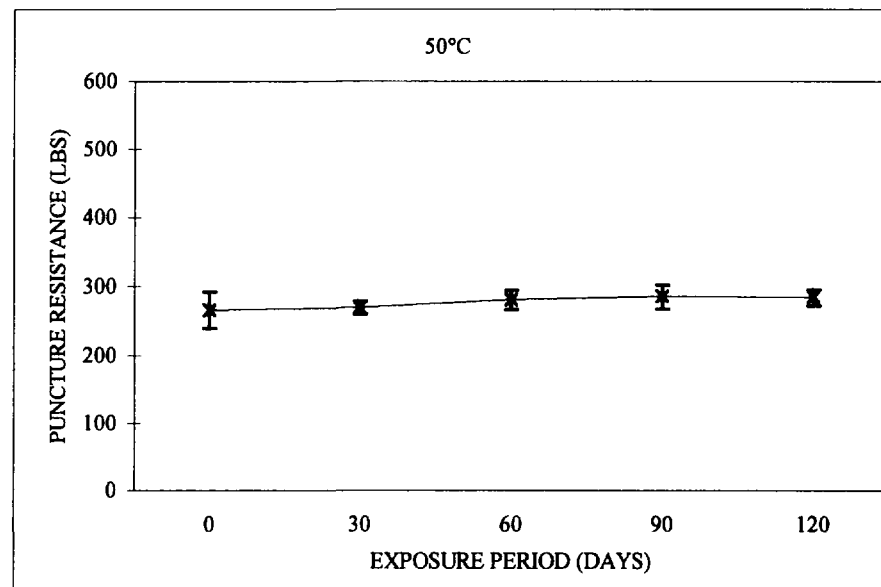
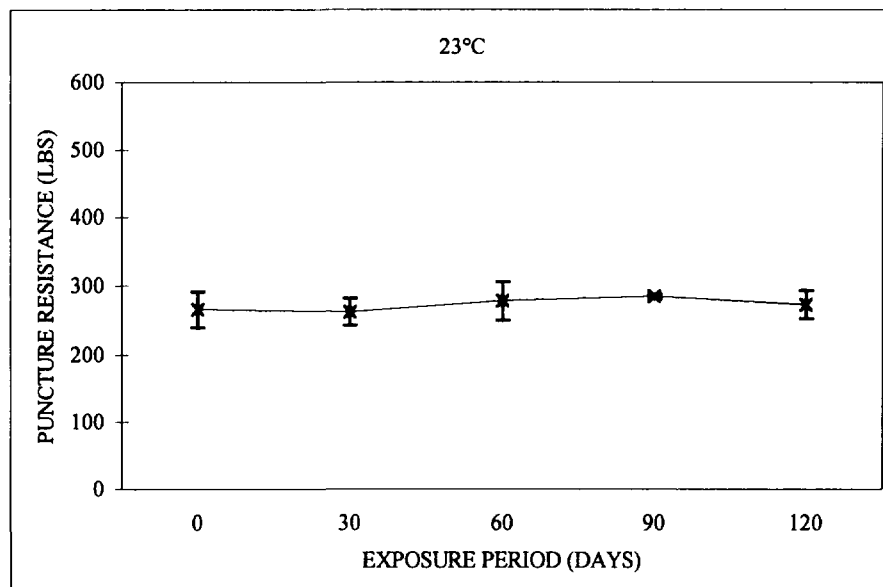
CHEMICAL COMPATIBILITY TEST RESULTS
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTEC JOB NO: GLI1096

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
 CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
 GEOSYNTEC SAMPLE NO: AL7890
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: ASTM D 4833

PROPERTY (UNIT): INDEX PUNCTURE RESISTANCE (LBS)
 DIRECTION: N/A

Exposure Period (Days)	23°C									50°C									Remarks						
	Specimens					Standard			Percent			Specimens					Standard			Percent					
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change	1	2		3	4	5	Mean	Deviation	Change
Control	235.1	274.1	303.4	249.6	267.6	265.96	25.94	0.0	235.1	274.1	303.4	249.6	267.6	265.96	25.94	0.0									
	245.6	247.8	271.3	285.8		262.63	19.34	-1.3	282.2	266.3	268.5	260.6		269.40	9.16	1.3									
	319.3	264.2	259.2	270.3		278.25	27.74	4.6	287.5	259.7	284.9	290.6		280.68	14.18	5.5									
	287.2	287.5	279.6	285.4		284.93	3.67	7.1	305.2	292.4	268.5	274.2		285.08	16.85	7.2									
	267.6	297.7	277.4	250.1		273.20	19.86	2.7	277.4	283.5	301.3	274.7		284.23	11.96	6.9									



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

EPA METHOD 9090

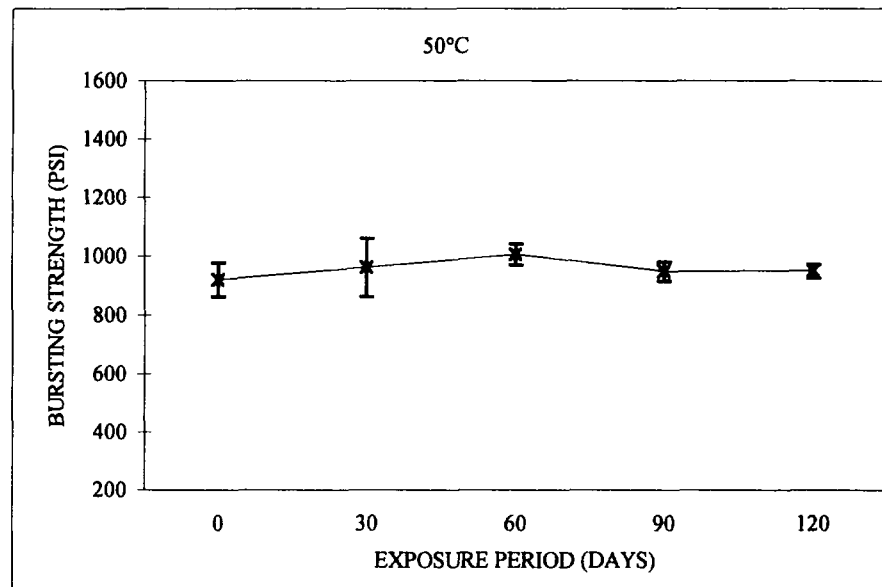
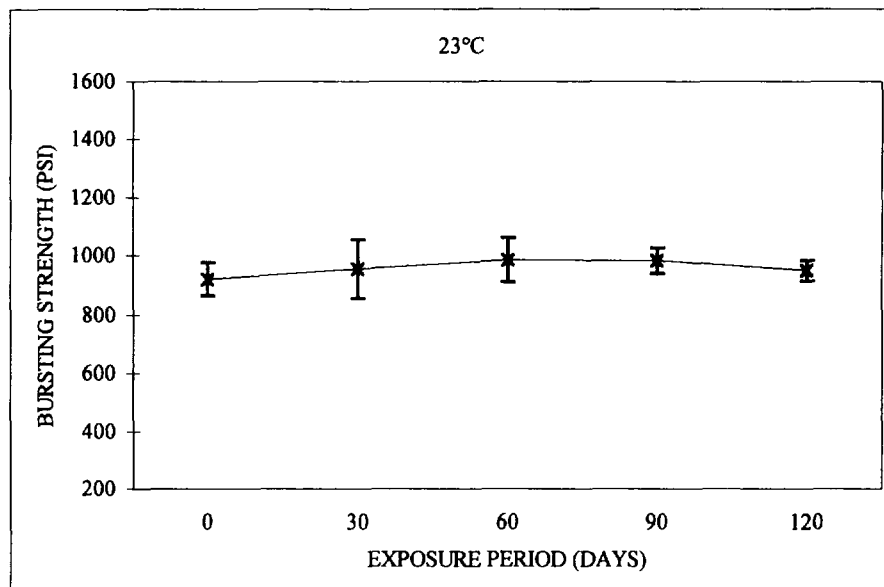
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 CLIENT PROJECT NO: C100003899.00
 CONTACT: GARY M. WANTLAND, P.E.
 PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
 GEOSYNTec JOB NO: GLI1096

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
 CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
 GEOSYNTec SAMPLE NO: AL7890
 IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
 TEST STANDARD: ASTM D 3786

PROPERTY (UNIT): HYDRAULIC BURSTING STRENGTH (PSI)

DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks							
	Specimens					Standard			Percent			Specimens						Standard			Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change		1	2	3	4	5	Mean	Deviation
Control																								
	1004	845	919	913	921	920.4	56.4	0.0	1004	845	919	913	921	920.4	56.4	0.0								
	1104	900	901	916		955.3	99.4	3.8	937	960	858	1092		961.8	97.2	4.5								
	1015	892	969	1069		986.3	75.0	7.2	1027	1022	1025	952		1006.5	36.4	9.4								
	990	919	1004	1017		982.5	43.7	6.7	934	921	943	997		948.8	33.4	3.1								
	926	977	915	984		950.5	35.0	3.3	951	919	970	964		951.0	22.8	3.3								



Note: Error bars represent one standard deviation at mean sample value.

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CHEMICAL COMPATIBILITY TEST RESULTS

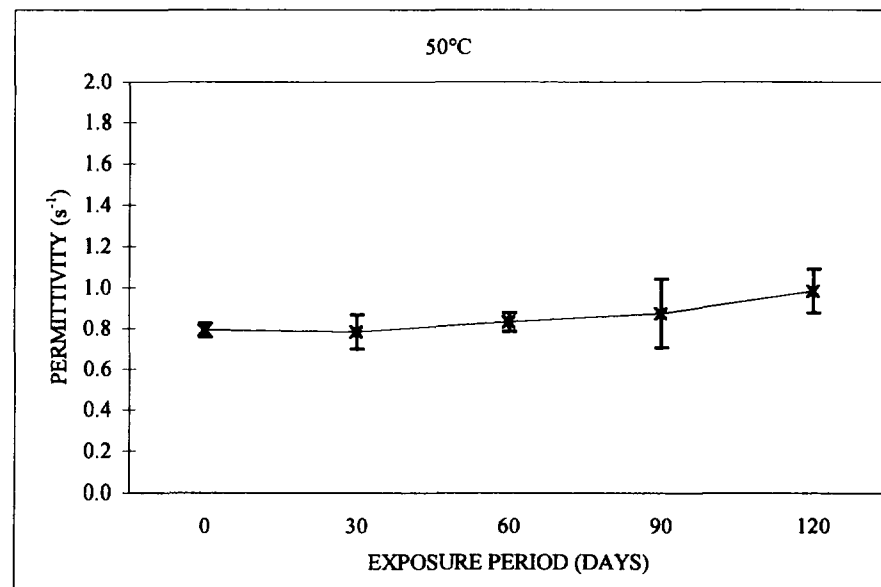
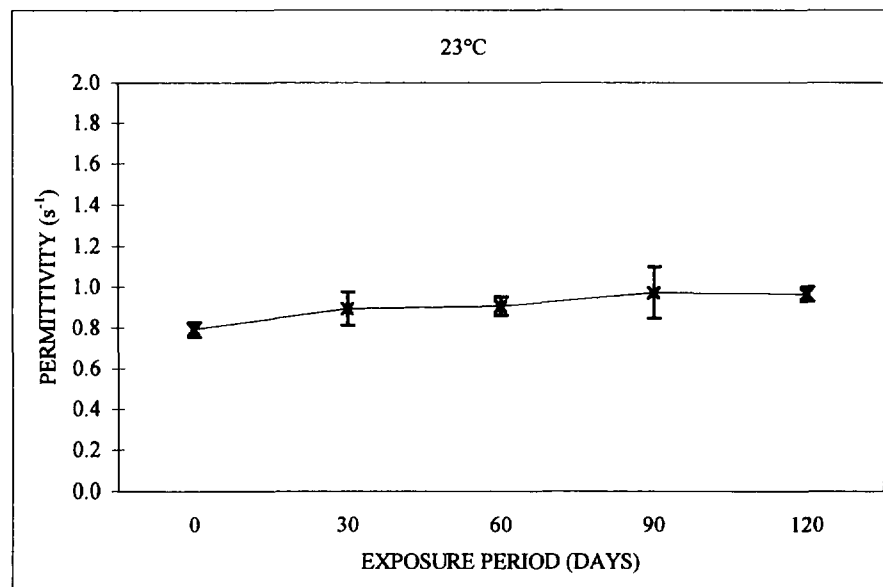
EPA METHOD 9090

CLIENT: URS GREINER WOODWARD CLYDE
CLIENT PROJECT NO: C100003899.00
CONTACT: GARY M. WANTLAND, P.E.
PROJECT NAME: SAUGET AREA 1 TSCA LANDFILL
GEOSYNTEC JOB NO: GL11096

MATERIAL TYPE: 16 OZ. PP NONWOVEN GEOTEXTILE
CLIENT SAMPLE ID: SYNTHETIC INDUSTRIES 16 OZ. NONWOVEN
GEOSYNTEC SAMPLE NO: AL7890
IMMERSION MEDIUM: PROJECT SPECIFIC SYNTHETIC LEACHATE
TEST STANDARD: ASTM D 4491 ⁽¹⁾

PROPERTY (UNIT): PERMITTIVITY (s^{-1})
DIRECTION: N/A

Exposure Period (Days)	23°C								50°C								Remarks
	Specimens					Standard Percent			Specimens					Standard Percent			
	1	2	3	4	5	Mean	Deviation	Change	1	2	3	4	5	Mean	Deviation	Change	
Control	0.75	0.81	0.78	0.83		0.79	0.04	0.0	0.75	0.81	0.78	0.83		0.79	0.04	0.0	
30	0.94	0.94	0.80			0.89	0.08	12.7	0.85	0.81	0.69			0.78	0.08	-1.2	
60	0.86	0.91	0.95			0.91	0.05	14.4	0.78	0.87	0.85			0.83	0.05	5.2	
90	1.02	0.83	1.07			0.97	0.13	22.8	0.91	0.69	1.02			0.87	0.17	10.2	
120	1.00	0.97	0.93			0.97	0.04	22.0	1.10	0.96	0.89			0.98	0.11	24.1	



Notes: 1. Permittivity tests were performed at 0.5-in. water head across the specimen.
2. Error bars represent one standard deviation at mean sample value.

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**PROJECT SPECIFIC
SYNTHETIC LEACHATE**

PROJECT SPECIFIC SYNTHETIC LEACHATE GENERATION

Soil and geosynthetic materials tested for chemical compatibility purposes during this testing program were exposed to a project specific synthetic leachate hereon referred to as synthetic leachate. The synthetic leachate was derived as follows:

- A bulk composite sample consisting of the grab sediment samples CSB-S1, CSB-S2, CSB-S3, CSB-S4, CSB-S5, CSB-S6, CSB-S7, CSB-S8, CSB-S9 and CSB-S10, recovered from the project site by O'Brien and Gere Engineers, Inc. in 5-gallon buckets, was formed by mixing equal portions by wet weight.
- The bulk composite sample was then used to generate the synthetic leachate in accordance with EPA Toxicity Characteristic Leaching Procedure (TCLP) extraction procedure, utilizing the standard solution No. 1 (pH=4.93).
- The extraction was conducted in 2-liter volumes and a total volume of approximately 80 liters of extract was generated in 40 batches.
- All of the extracted liquid was then transferred into a large container creating a composite extracted liquid, which was then used in the testing program as the synthetic leachate.

ATTACHMENT 8
HDPE ELONGATION EVALUATION

Attachment 8

HDPE Elongation Evaluation

Job Solutra SargatDescription HDPE ElongationProject No. C1-3899.00Computed by SMWChecked by JDHPage of Sheet 1 of 2Date 10 Jan 01Date 10-1-01

Reference

Problem Evaluate strain in HDPE due to differential settlement of landfill base

Given Total settlement values for various points on landfill base are attached fig.

Analysis

Maximum differential settlement

$$4.1 - 2.0 = 2.1 \text{ inches}$$

Calculate strain values

$$\frac{\frac{1}{12}(4.1 - 2.0)(100)}{325'} = 0.054\% \quad \frac{\frac{1}{12}(4.1 - 2.9)(100)}{130'} = 0.077\%$$

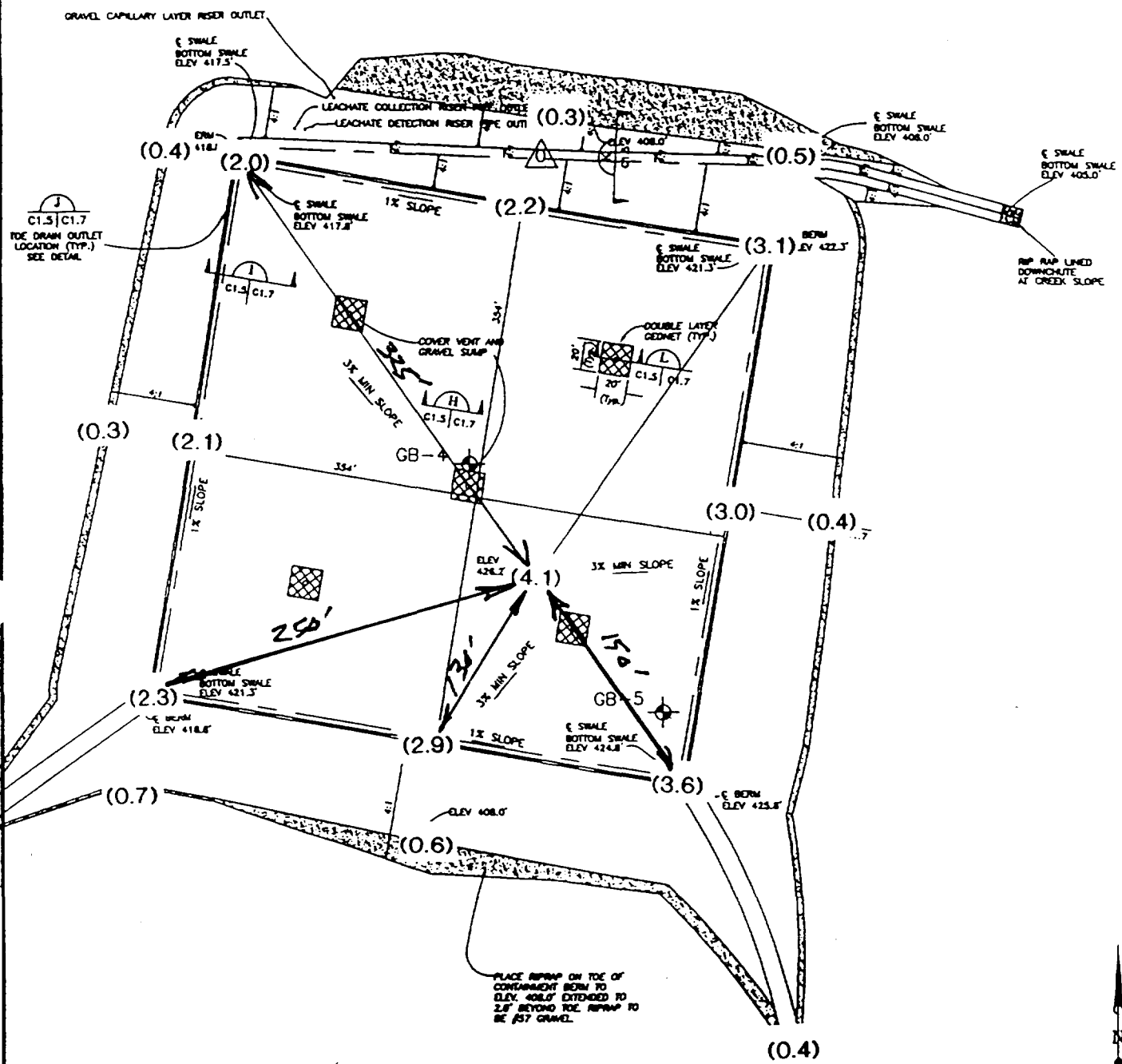
$$\frac{\frac{1}{12}(4.1 - 2.3)(100)}{250} = 0.06\% \quad \frac{\frac{1}{12}(4.1 - 3.6)(100)}{150'} = 0.028\%$$

Observed strain due to differential settlement of the bottom varies from 0.028% to 0.077%

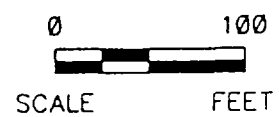
All values are << HDPE yield strain of 13%

Pg 27
2

File: E:\022\C1.5 DWG Last edited: NOV. 20, 00 08:51 a.m. URS C:\



LEGEND
 ◆ BORING LOCATION
 (6.0) - ESTIMATED
 TOTAL SETTLEMENT



TSCA CELL INVESTIGATION SAUGET AREA 1 CAHOKIA, ILLINOIS		PROJECT NO. 2399STL022.01
URS		
DRN. BY: djd 11/20/00 DSGN. BY: tlc CHKO. BY: [signature]	Estimated Total Settlements Plan View	FIG. NO. 4

ATTACHMENT 9
GEONET EQUIVALENT PERFORMANCE

ATTACHMENT 9

Grant Equivalent Performance

Problem Verify that a - gravel layer is equivalent to 12 inches of sand with $k = 1 \times 10^{-2} \text{ cm/sec}$

Given Use Terzaghi "cut short" for manometer data

Analysis Transmissibility of sand $T = Kt$
 $= 1 \times 10^{-2} \frac{\text{cm}}{\text{sec}} \times 30.48 \text{ cm}$
 $= 0.305 \frac{\text{cm}^2}{\text{sec}}$

Terzaghi CE 450

T varies with σ_v

$\sigma_v \Rightarrow$ water $15 \text{ ft} \times 115 \text{ pcf} = 1725$
 linear system $2 \text{ ft} \times 110 \text{ pcf} = 220$
 con system $5/2 \times 110 \text{ pcf} = \frac{550}{2475 \text{ pcf}}$
 $\sigma_v =$

$(1 \text{ kpa} = 20.8 \text{ pcf}) \therefore \sigma_v = \frac{2475}{20.8} = 120 \text{ kpa}$

From chart $T = 1.05 \times 10^{-8} \frac{\text{m}^2}{\text{sec}}$

converting to $\frac{\text{cm}^2}{\text{sec}} \Rightarrow T = 1.05 \times 10^{-8} \frac{\text{m}^2}{\text{sec}} \times \left(\frac{100 \text{ cm}}{\text{m}} \right)^2$

$T = 1.05 \times 10^{-8} \times 10^4 = 1.05 \times 10^{-4} \frac{\text{cm}^2}{\text{sec}}$

$T_{\text{net}} > T_{\text{and/or}}$

TENAX CE

Type: **450 - 600 - 750 - 900**
Geonets



TENAX CE geonets are high profile rhomboidal shaped mesh structures made by two sets of overlaid intersecting strands. The intersecting strands form overlaid sets of continuous deep channels which provide high flow capacity. These geonets are used in waste disposal and general civil engineering projects, where a high flow capacity is required.

TENAX CE geonets are manufactured from extrusion of High Density Polyethylene (HDPE), black in color; they are inert to chemical and biological conditions normally occurring in soil. Moreover they are treated with special additives to resist UV degradation.

TENAX CE geonets are available in a wide range of thicknesses and widths, so as to satisfy any design and installation need.

Typical applications

Load distribution, site leveling and mechanical protection of the geomembrane; drainage of the accidental leaks below primary; leachate and rain water collection above primary geomembrane; mechanical protection of the geomembranes when in contact with waste-materials and/or soil; drainage of liquids and gases present in the soil above and/or below the capping geomembrane.

PHYSICAL CHARACTERISTICS		CE 450	CE 600	CE 750	CE 900	notes
STRUCTURE		2 strands	2 strands	2 strands	2 strands	
POLYMER TYPE		HDPE	HDPE	HDPE	HDPE	
U.V. STABILIZER		carbon black	carbon black	carbon black	carbon black	
FOAMING AGENT		NO	NO	NO	NO	

DIMENSIONAL CHARACTERISTICS	UNIT	CE 450	CE 600	CE 750	CE 900	notes
THICKNESS at 20 kPa	mm	4.0	4.5	5.0	5.5	a,c
THICKNESS at 200 kPa	mm	3.8	4.2	4.8	5.2	a,c
UNIT WEIGHT	g/m ²	450	600	750	900	a,d
ROLL WIDTH	m	2.3	2.3	2.3	2.3	a,g
ROLL LENGTH	m	100	50	50	50	a
ROLL DIAMETER	m	0.78	0.56	0.58	0.62	a
ROLL VOLUME	m ³	1.41	0.73	0.79	0.89	a
ROLL GROSS WEIGHT	kg	103.5	69.0	86.3	103.5	a

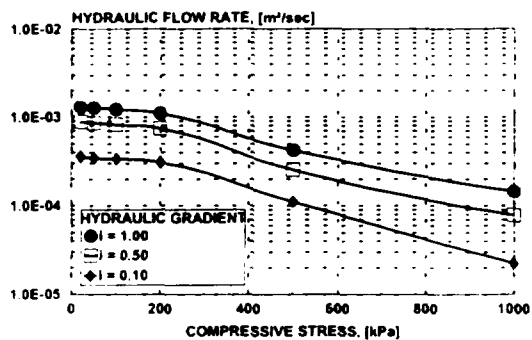
TECHNICAL CHARACTERISTICS	UNIT	CE 450	CE 600	CE 750	CE 900	notes
HYDRAULIC FLOW RATE						
i=1 σ_v = 20 kPa	m ³ / sec	1.18 E-03	1.39 E-03	1.41 E-03	1.44 E-03	a,b,e
i=1 σ_v = 100 kPa	m ³ / sec	1.11 E-03	1.31 E-03	1.33 E-03	1.36 E-03	a,b,e
i=1 σ_v = 200 kPa	m ³ / sec	1.00 E-03	1.24 E-03	1.26 E-03	1.28 E-03	a,b,e
i=1 σ_v = 500 kPa	m ³ / sec	3.84 E-04	7.61 E-04	9.26 E-04	1.09 E-03	a,b,e
TENSILE STRENGTH	kN / m	4.0	5.0	7.0	9.0	a,b,f
ELONGATION AT PEAK	%	80	30	30	30	a,b,f

NOTES:

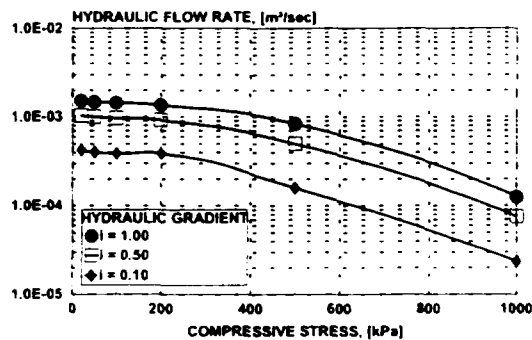
- a) Typical values
- b) Longitudinal direction
- c) ISO 9863
- d) ISO 9864
- e) ASTM D4716
- f) ISO 10319
- g) Upon request available 3.8 m wide

Typical Hydraulic Characteristics

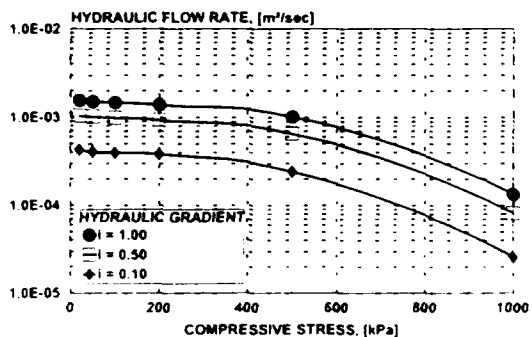
TENAX CE 450



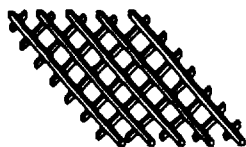
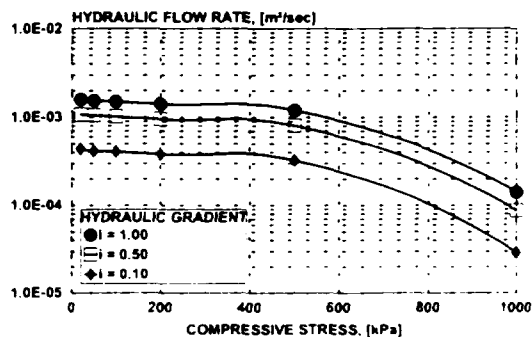
TENAX CE 600



TENAX CE 750



TENAX CE 900



TENAX CE



TENAX SpA
Geosynthetics Division
 Via dell'Industria, 3
 I-23897 Viganò (LC) ITALY
 Tel. (+39) 039.9219307
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 CH-6900 Lugano SWITZERLAND
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 Fax (+41) 091.9242489
 e-mail: geo@tenax.ch
 Web Site: www.tenax.net

ATTACHMENT 10
PRIMARY COLLECTION SYSTEM LEACHATE
HEAD THICKNESS ESTIMATE

$$C = 3.44 \text{ inches} / 24 \text{ hrs} = 0.0001 \text{ cm/sec} \times 10^{-2}$$

$$\alpha = \tan^{-1} (2.7/226) = 1.95^\circ = 0.03403 \text{ rad}$$

$$\Delta h = 409.7' - 402.0' = 7.7 \text{ feet}$$

$$L/2 = 226 \text{ feet (as measured from drawings)}$$

Calculations:

where $L/2$ = Distance from high point to drain
 C = infiltration rate/drainage layer (k)
 α = bottom slope angle
 from: EPA Landfill Guidance, by G. Richardson

$$H_{\max} = \frac{L^2 C}{2 \tan^2 \alpha} + 1 - \frac{C}{\tan^2 \alpha} \left[\tan^2 \alpha + C \right]$$

Equation: The maximum head on a lining can be estimated from the following equation:

This recurrence interval may be excessive considering the relatively short construction duration when the landfill cell will still be open. The 3.44 inch rainfall depth may be overly conservative, but was used anyway. The reference above shows that the rainfall depth is less than 2.5 inches for 9 month recurrence interval events (24 hr).
 The 3.44 inch depth was determined to correspond to a 30 month - 24 hr rainfall event. The event recurrence interval was determined using the data provided in "Frequency Distributions and Hydrologic Characteristics of Heavy Rainstorms in Illinois" by Huff & Angel, 1989.

Purpose: Use the Boussinesq equation w/ Dupuit Forchheimer assumptions to calculate the maximum leachate head over the primary lining. These calculations are to check the output of the HELP model under the construction case.
Assumptions: The HELP model synthetic weather generator estimated a peak daily rainfall amount of 3.44 inches. This rainfall depth will be assumed to correspond to the maximum leachate depth computed by the model.

Job	Solving Seepage
Description	Maximum Leachate Head
	over Primary Lining (Head Calc)
Project No.	C10004051.00
Computed by	M. Bingham
Checked by	Gm
Date	1/22/01
Date	1/22/01
Sheet	L of 2
Page	1 of 1
Reference	

URS

Solids Sarged

Maximum Leakage Head

over Primary Living (Hard Calc)

Project No. C10004054.00

Computed by M. Banaagand

Checked by GR

Page 2 of 2

Sheet 2 of 2

Date 1/22/01

Date 1/22/01

$$H_{max} = 226 \sqrt{0.01} \left[\frac{0.01}{0.03403} \right] + 1 - \frac{0.01}{0.03403} \left[\frac{0.01}{0.03403} \right] + 0.0$$

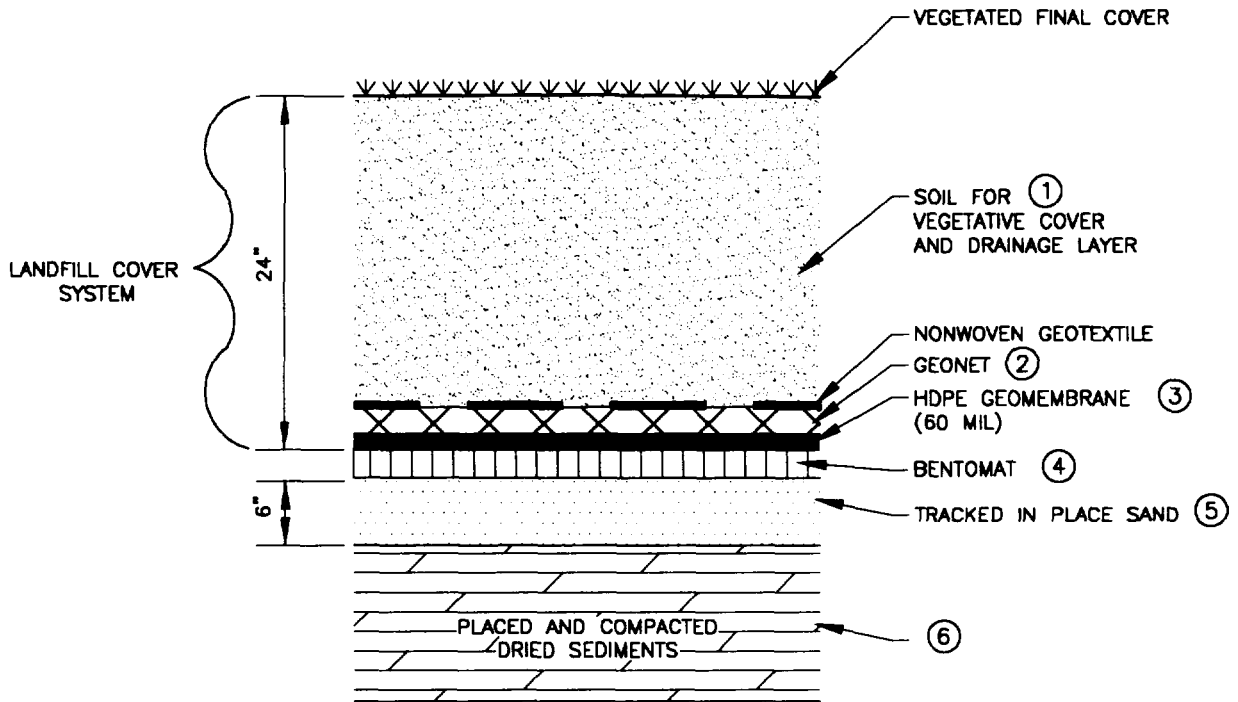
$$= 226 \sqrt{0.01} [0.756]$$

$$= 17.1'$$

Summary:

The hard analysis proves that the results of the HELL model include a significant damping of the stormwater inputs.

HELP EVALUATION DIAGRAM
CLOSED LANDFILL CASE
PAGE 1 OF 12



LEGEND

⑦ HELP ANALYSIS LAYER NO.

THICKNESSES SHOWN ARE
COMPACTED THICKNESSES

NOT FOR CONSTRUCTION

S:\C10000\4000\1\NEW FIGURES\PC1_CLOINDF.DWG 01/22/01 15:24

S:\C10000\4000

PREPARED FOR: SOLUTIA
URSGWC JOB NUMBER: C100003899.00
URS Greiner Woodward Clyde
A Division of URS Corporation
7650 W. Courtney Campbell Causeway
Tampa, Florida 33607-1462
Tel: 813.286.1711 Fax: 813.287.8591

Drawn: W. WEBER
Design: GARY WANTLAND
Checked: GARY WANTLAND
Date: JUNE 20, 2000

PROJECT NAME
**SOLUTIA INC.
SAUGET AREA 1**
DRAWING TITLE
COVER SYSTEM DETAIL

FIGURE
5-2

S:\C10000\4000\4000-79\EPA COMMENT RESPONSE\REVISED FIGURES\C1_0_LINREDT_REV.DWG 11/01/00 11:02

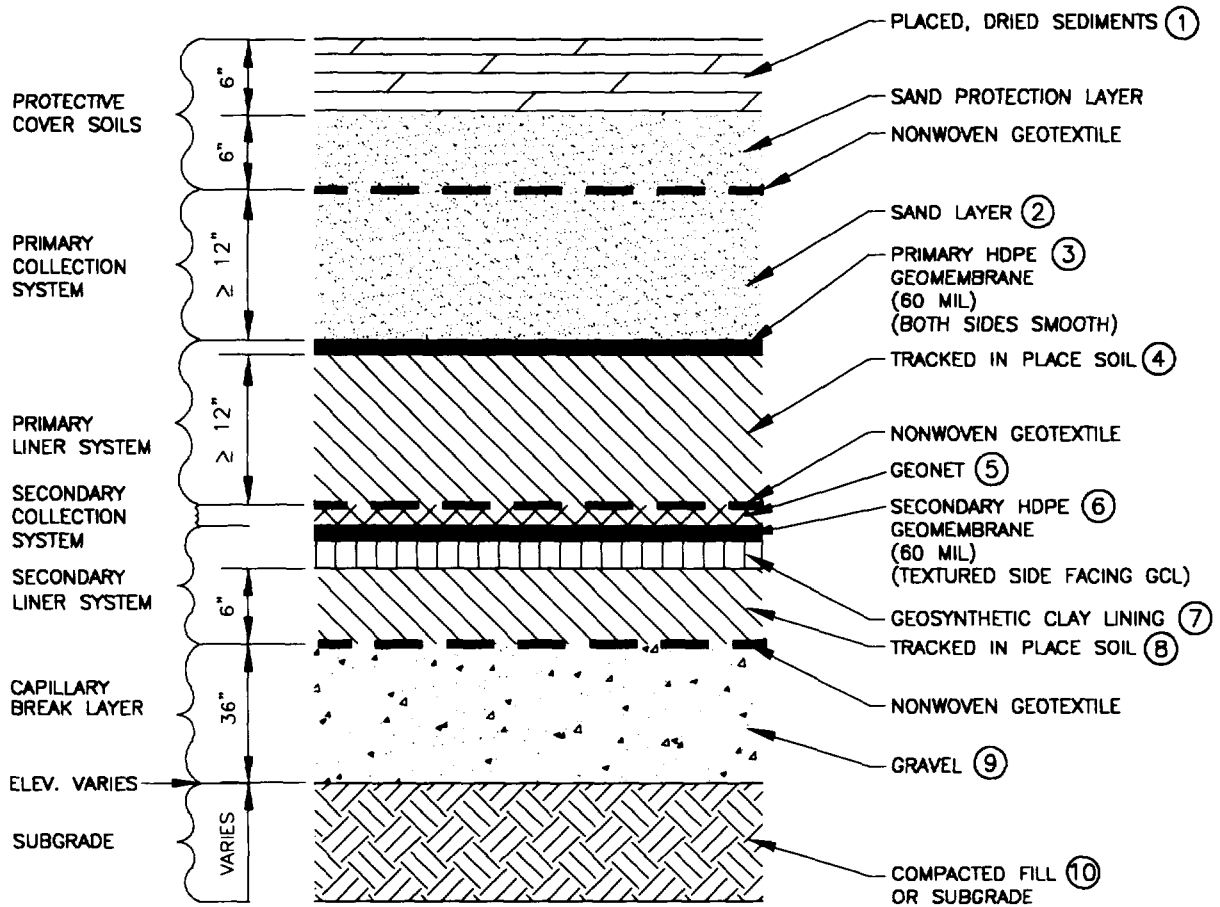


A **BOTTOM LINER SYSTEM DETAIL**
C1.4 | C1.6 **N.T.S.**

1. NOT FOR CONSTRUCTION
2. LAYER THICKNESSES SHOWN ARE COMPACTED THICKNESS

PREPARED FOR: SOLUTIA URS/GWC JOB NUMBER: C100003899.00 URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1482 Tel: 813.286.1711 Fax: 813.287.8591	Drawn: R. HAYDEN Design: M. BRUNGARD Checked: G. WANTLAND Date: OCT. 30, 2000	PROJECT NAME SOLUTIA INC. SAUGET AREA 1 DRAWING TITLE BOTTOM LINER SYSTEM DETAIL	FIGURE 4-1
--	--	---	---------------------------------

HELP EVALUATION DIAGRAM
CONSTRUCTION CASE
PAGE 1 OF 21



LEGEND

⑥ HELP ANALYSIS LAYER NO.

A BOTTOM LINER SYSTEM DETAIL
C1.4/C1.6 N.T.S.

NOTES

1. NOT FOR CONSTRUCTION
2. LAYER THICKNESSES SHOWN ARE COMPACTED THICKNESS

S:\C10000\4000\LEPA COMMENT RESPONSE\REVISED FIGURES\C1.6_LINER DETL REV.DWG 11/01/00 11:02

PREPARED FOR: SOLUTIA URS GWC JOB NUMBER: C100003899.00 URS Greiner Woodward Clyde A Division of URS Corporation 7850 W. Courtney Campbell Causeway Tampa, Florida 33607-1482 Tel: 813.288.1711 Fax: 813.287.8501	Drawn: R. HAYDEN Design: M. BRUNGARD Checked: G. WANTLAND Date: OCT. 30, 2000	PROJECT NAME SOLUTIA INC. SAUGET AREA 1 DRAWING TITLE BOTTOM LINER SYSTEM DETAIL	FIGURE 4-1
--	--	---	---------------

ATTACHMENT 12
GEOTEXTILE CLOGGING POTENTIAL EVALUATION

Job Solutra Sargit

Project No. C1-3899.00

Page of

Description Geotextile Cladding

Computed by Gmm

Sheet 1 of 1

Checked by JHO

Date 10 Jan 01

Date 12/10-01

Reference

Problem Evaluate geotextile cladding potential for placed and compacted sediments

Given Fabric - 1602 nonwoven continuous filament
 use Synthetic Industries 1601 fabric
 Sediment - use assumed conservative gradation based on site specific soils (attached)
 $\therefore d_{85\%} = 0.035 \text{ mm}$
 $d_{15\%} = 0.0015 \text{ mm}$

Fabric AOS = #140 = 0.1 mm

Analysis Based on hydraulic load to leachate collection system use

$$\frac{Q_{5\% \text{ soil}}}{d_{85\% \text{ soil}}} < 3 \Rightarrow \frac{0.1}{0.035} = 2.8 \quad \text{ok}$$

$$\frac{Q_{95\%}}{d_{15\% \text{ soil}}} > 3 \Rightarrow \frac{0.01}{0.0015} = 6.6 \quad \text{ok}$$

Proposed 1602 nonwoven fabric will meet the design stds.



Geotex[®] Nonwoven Geotextiles – METRIC VALUES

Earthstopping Solutions

PROPERTY	TEST METHOD	UNITS	VALUE	311	351	401	451	501	601	701	801	1001	1201	1601
MECHANICAL														
Grab Tensile Strength	ASTM D-4632	N	TYPICAL	400	485	575	600	730	820	930	1020	1220	1510	1820
			MARV	355	420	510	530	665	710	800	900	1110	1335	1690
Grab Elongation	ASTM D-4632	%	TYPICAL	60	60	60	60	60	60	60	60	60	60	60
			MARV	50	50	50	50	50	50	50	50	50	50	50
Puncture Strength	ASTM D-4833	N	TYPICAL	265	285	330	330	445	465	530	575	775	890	1220
			MARV	220	240	285	285	375	375	445	485	665	775	1065
Mullen Burst	ASTM D-3786	kPa	TYPICAL	1375	1430	1650	1860	2275	2205	2550	2685	3650	4410	5790
			MARV	1030	1270	1445	1585	1930	1930	2275	2410	3170	3995	5170
Trapezoidal Tear	ASTM D-4533	N	TYPICAL	175	220	265	265	355	310	400	420	530	600	755
			MARV	130	175	220	220	220	265	330	375	445	510	665
HYDRAULIC														
Apparent Opening Size (AOS)	ASTM D-4751	mm	TYPICAL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.106	0.106	0.106
			MARV	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.180	0.150	0.150	0.150
Permittivity	ASTM D-4491	sec ⁻¹	TYPICAL	2.70	2.60	2.40	2.20	2.10	1.80	1.80	1.80	1.50	1.30	1.00
			MARV	2.00	2.00	2.00	1.50	1.40	1.30	1.50	1.50	1.20	1.00	0.70
Permeability	ASTM D-4491	cm/sec	TYPICAL	0.29	0.39	0.30	0.29	0.28	0.32	0.38	0.48	0.40	0.40	0.39
			MARV	0.22	0.25	0.22	0.22	0.23	0.24	0.34	0.38	0.30	0.29	0.27
Water Flow Rate	ASTM D-4491	l/min/m ²	TYPICAL	6925	6110	6315	5500	5090	4885	5295	4885	4480	3665	2850
			MARV	4480	4480	5700	4885	4685	4480	4480	4480	3460	3055	2035
ENDURANCE														
UV Resistance	ASTM D-4355	% Retained @ 500 hrs	MARV	70	70	70	70	70	70	70	70	70	70	70
STANDARD PACKAGING														
Roll Width	Measured	meter	TYPICAL	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	4.57	4.57	4.57	4.57
Roll Length	Measured	meter	TYPICAL	109.8	109.8	109.8	109.8	109.8	91.5	91.5	91.5	91.5	91.5	91.5
Roll Area	Calculated	m ²	TYPICAL	418.05/501.66	418.05/501.66	418.05/501.66	418.05/501.66	418.05/501.66	348.38/418.05	348.38/418.05	418.05	418.05	418.05	418.05

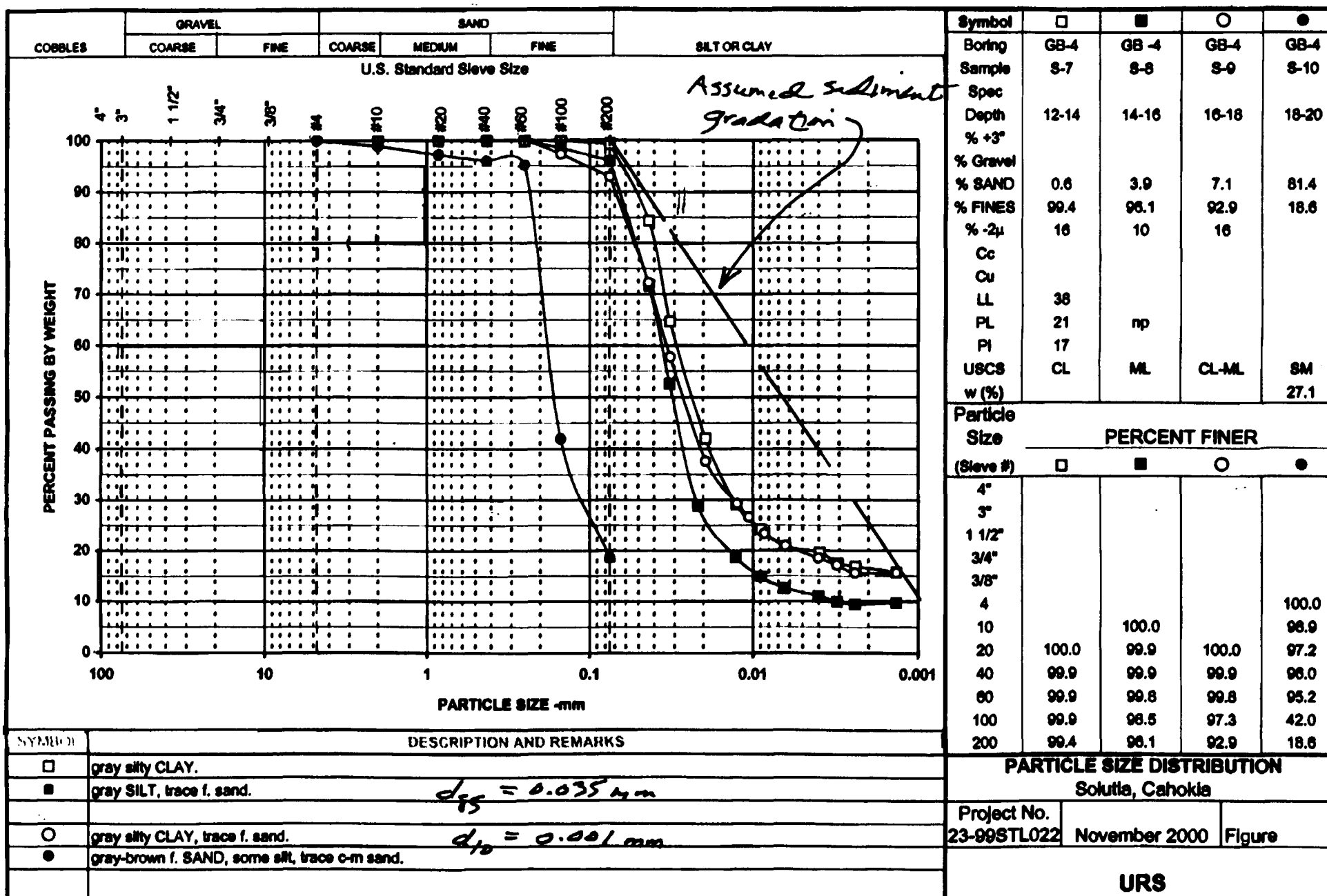
NOTES

▲ Values reported in weaker principle direction.

▲ "MARV" indicate minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.



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ATTACHMENT 13
REVISED TECHNICAL SPECIFICATION 02245
(Geosynthetic Clay Liner)

GEOSYNTHETIC CLAY LINER (GCL)

1.1 SECTION INCLUDES

- ## 1.2 REFERENCES

- URS**

1.3 SUBMITTALS

- A. Pre-installation: Submit the following to the Engineer for approval prior to GCL deployment.
1. Manufacturer's specification for GCL which includes properties contained in Tables 1 and 2.
 2. Written certification that the GCL meets the properties listed in Tables 1 and 2.
 3. Written certification that GCL manufacturer has continuously inspected GCL for the presence of needles and found GCL to be needle-free.
 4. Written certification from the GCL manufacturer that the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
 5. Quality control certificates signed by a responsible entity of the GCL manufacturer. Each quality control certificate shall include roll identification numbers, and results of quality control tests. At a minimum, results shall be given for tests and corresponding methods specified in Tables 1 and 2.
 6. Written certification that sealing material is made of same natural sodium bentonite as the GCL.
- B. Installation: Submit the following as installation proceeds: Subgrade surface acceptance, signed by the Contractor for each area that will be covered directly by GCL.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping
1. GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers.
 2. GCL rolls shall be marked or tagged with the following information:
 - a. Manufacturer's name
 - b. Product identification
 - c. Roll number
 - d. Roll dimensions

e. Roll weight

B. Storage and Protection:

1. The Contractor shall provide on-site storage area for GCL rolls from time of delivery until installation. Rolls of GCL will be stored off the ground from time of delivery until they are installed.
2. After Contractor mobilization, store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage.
3. Preserve integrity and readability of GCL roll labels.

PART 2 PRODUCTS

2.1 MATERIALS

- A. The active ingredient of the GCL shall be natural sodium bentonite. The bentonite shall be encapsulated between two polypropylene textiles.
- B. For side slopes steeper than 7H:1V the GCL shall be needle punched with high strength polypropylene thread to provide internal shear strength reinforcing. The internal shear reinforcing mechanism shall resist failure due to thread pull-out over long-term creep situations.
- C. The textiles shall be sufficiently porous to allow bentonite flow-through such that the permeability of the overlap seams is equal to or less than the permeability of the body of the GCL sheet without the addition of granular or paste bentonite.
- D. The bentonite and textiles used to manufacture the GCL shall have the following minimum properties:

TABLE 1

Test Designation	Test Method	Frequency of Testing	Report Value
Clay ¹			5
Free swell	D 5890	One per truck or railcar but min., every 50 tonnes	Minimum average
Fluid loss	D 5891	One per truck or railcar but min., every 50 tonnes	Minimum average
Geosynthetic Materials			5

Test Designation	Test Method	Frequency of Testing	Report Value
Geotextiles			
Mass per unit area	D 5261	20,000 m ² (200,000 ft ²)	Typical and MARV MARV
Grab tensile strength (MD and CD)	D 4632	20,000 m ² (200,000 ft ²)	
Finished GCL ²			
Clay mass per unit area (dried) ³	D 5993	4,000 m ² (40,000 ft ²)	MARV
Clay moisture content	D 4643	4,000 m ² (40,000 ft ²)	Average value ⁶ MARV
Grab tensile strength (MD and CD) ⁴	D 4632	20,000 m ² (200,000 ft ²)	
Index flux ⁵	D 5887	Once weekly with the last 20 values reported ⁷	Maximum value

- E. The final GCL product shall have the following minimum properties:

TABLE 2

Property	Test Method	Value	Units	Min. Test Freq.
Bentonite Content @ 20% Moisture Content	Weigh 12" x Roll Width	1.0	lbs/sq ft	1/20,000 sf
Confined Swell	GRI-GCL-1	150	%	1/300,000 sf
Permeability under 5 psi effective confining pressure	ASTM D5084	5×10^{-9}	cm/sec	1/1,000,000 sf
Overlap Seam Permeability under psi effective confining pressure	ASTM D5084	5×10^{-9}	cm/sec	1/1,000,000 sf
Hydrated Internal Residual Shear Resistance*	ASTM D5321	10	degrees	Periodic
Hydrated Internal Residual Shear Resistance**	ASTM D532	16	degrees friction angle	Periodic
Grab Strength	ASTM D 4632	150	lbs	1/200,00 ft ²

* For side slopes less than or equal to 7H:1V.

** For side slopes steeper than 7H:1V. Residual shear strength measured at 3" of displacement.

- F. The bentonite shall be continuously adhered to both geotextiles to ensure that the bentonite will not be displaced during handling, transportation, storage and installation, including cutting, patching and fitting around penetrations.
- G. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and shall be as recommended by the GCL manufacturer.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

- A. The Construction Manager shall obtain certification from the Installer that the surface on which the GCL will be placed is acceptable. The Certificate of Acceptance shall be provided prior to GCL installation.
- B. After the surface has been accepted by the Installer, it is the Installer's responsibility to indicate to the Construction Manager any change in surface condition that may require repair. If the Construction Manager concurs with the Installer, then the Earthwork Subcontractor shall be notified and the Construction Manager shall confirm that the surface is repaired.
- C. The subgrade shall be maintained at the specified moisture content until covered by the GCL. Upon placement of panel(s), the Installer is responsible for maintaining/repairing the surface covered by the GCL unless otherwise agreed.

3.2 EXAMINATION

- A. The Engineer will collect samples of GCL to be installed for conformance testing.

3.3 INSTALLATION

- A. GCL Deployment: Handle GCL in a manner to ensure it is not damaged. At a minimum, comply with the following:
 - 1. On slopes, anchor the GCL securely and deploy it down the slope in a controlled manner.
 - 2. Weight the GCL with sandbags or equivalent in the presence of wind.
 - 3. Cut GCL with a geotextile cutter (hook blade), scissors, or other approved device. Protect adjacent materials from potential damage due to cutting of GCL.
 - 4. Prevent damage to underlying layers during placement of GCL.
 - 5. During GCL deployment, do not entrap in or beneath GCL, stones, trash, or moisture that could damage GCL.
 - 6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
 - 7. Do not place GCL in the rain or at time of impending rain.

8. Do not place GCL in areas of ponded water.
9. Replace GCL that is hydrated before placement of overlying geomembrane.
10. In general, only deploy GCL that can be covered during that day by geomembrane or a minimum of twelve (12) inches of approved cover soil.
11. Orient the preferred GCL surface in relation to prepared soil or other geosynthetics as directed by the Representative.
12. On side slopes, run GCL to the bottom of the slope as indicated.
13. Seam areas or runs shall also be flat and clear of any large rocks, debris or ruts.
14. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases.
15. Overlaps shall be a minimum of six (6) inches.
16. A proper seam shall cover the six (6) inch lap line and leave the nine (9) inch match line exposed.
17. The Contractor shall only work on an area that can be completed in one working day.
18. Completion shall be defined as the full installation and anchoring of the liner and placement of the overlying specified geomembrane liner.

B. Overlaps:

1. On slopes, overlap GCL to the manufacturer's match line
2. In general, no horizontal seams are allowed on side slopes. Any horizontal seams on side slopes will be overlapped so that liquid will run from the top of the higher panel to the top of the lower panel. GCL shall not be placed so that liquid from a higher panel can run underneath a lower panel.
3. Apply granular bentonite to overlapped area at a rate of 1/4 pound per linear foot.
4. At sumps, overlap GCLs at least one (1) foot.
5. At bottom of collection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams.
6. Seams shall be augmented with granular bentonite to ensure seam integrity.

7. Granular bentonite shall be dispersed evenly from the panel edge to the lap line at a minimum rate of $\frac{1}{4}$ pound per linear foot continuously along all seams or overlap areas.
8. Accessory bentonite shall be of the same type as the material within the composite liner itself. Adhesives may be used on seams to keep panels in contact during backfill operations, if necessary.

C. Defects and Repairs:

1. Repair all flawed or damaged areas by placing a patch of the same material extending at least one (1) foot beyond the flaw or damaged area.
2. Treat seams of repaired areas as per stated in Overlaps above.
3. The edges of the patch shall be fastened to the repaired liner with construction adhesive, in addition to the bentonite-enhanced seam.

D. Interface with Other Products: Ensure the following when deploying overlying material.

1. GCL and underlying materials are not damaged.
2. Minimal slippage of GCL on underlying layers occurs.
3. No excess tensile stresses occur in GCL.

3.4 ANCHOR TRENCH SYSTEMS

- A. Anchor trenches shall be excavated to the lines and grades shown on the Drawings prior to placement of the GCL.
- B. To minimize desiccation of the clay, no more than the amount of trench required for the GCL to be anchored in one day shall be excavated.
- C. The corners of the anchor trench where the GCL enters the trench shall be rounded to a smooth radius prior to the installation of the GCL.
- D. No loose soil shall be allowed to underlie the GCL in the anchor trench.
- E. The GCL shall be temporarily anchored with sand bags or other approved means until the overlying geosynthetics are placed and secured.

3.5 EQUIPMENT

A. Storage

1. Wooden pallets for above ground storage of GCL.
2. Heavy, waterproof tarpaulin for protecting unused GCL.

B. Installation

1. Equipment used for GCL deployment shall utilize a spreader bar to prevent slings from damaging edges.
2. Steel pipe shall be inserted into roll core for lifting.
3. Sand bags for securing tarpaulin.
4. 3-inch wide grips for moving GCL panels into place for each installation technician.
5. Bentonite Sealing Compound and/or Granular Bentonite for securing around penetrations and structures.
6. Equipment used for the placement of all liners above the GCL shall not exceed a ground pressure of four (4) psi.

3.6 CONFORMANCE TESTING

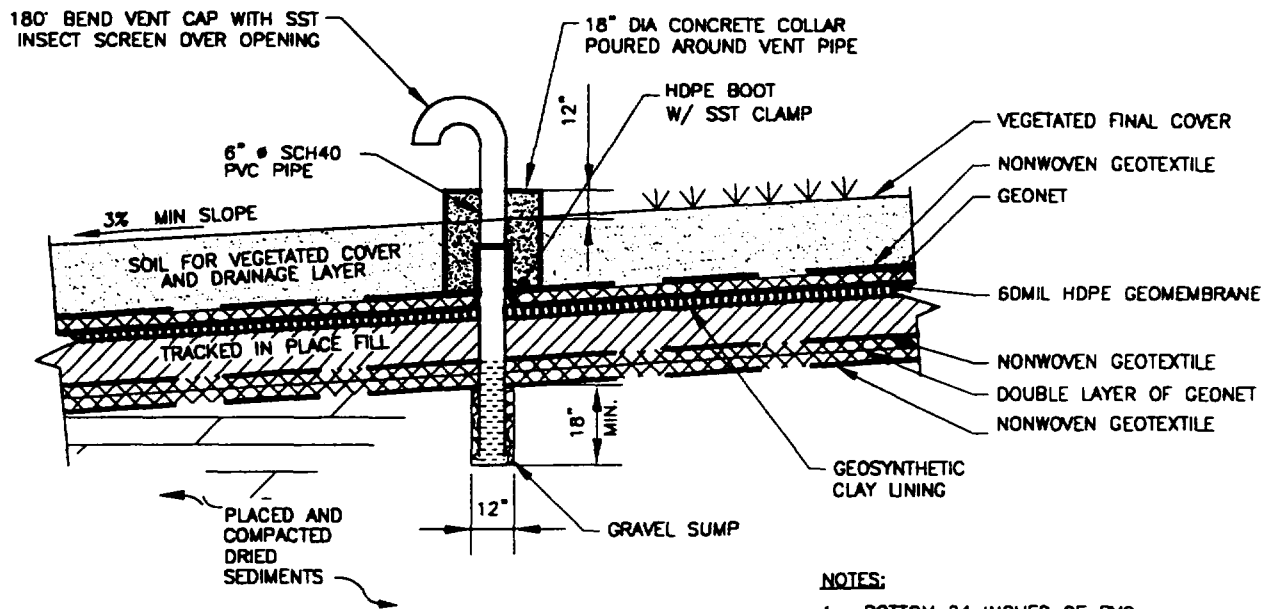
- A. Within 30 days of award, Contractor shall submit the results of the following interface friction tests:

- | | | |
|--------------------|-------------------------|-------------|
| • Compacted Soil - | Geosynthetic Clay Liner | ASTM D 5321 |
| • Textured HDPE - | Geosynthetic Clay Liner | ASTM D 5321 |

END OF SECTION 02245

ATTACHMENT 14
FIGURE 5-3: TYPICAL COVER VENT

S:\C10000\1\00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 5-3_TYPICAL COVER VENT.DWG 06/20/00



NOTES:

1. BOTTOM 24 INCHES OF PVC PIPE SHALL BE SLOTTED.
2. DOUBLE LAYER OF GEONET FOR VENT SHALL BE 20FT X 20FT IN PLAN.

<p>PREPARED FOR: SOLUTIA</p> <p>SGWC JOB NUMBER: C100003899.00</p> <p>URS Greiner Woodward Clyde</p> <p>A Division of URS Corporation</p> <p>7850 W. Courtney Campbell Causeway</p> <p>Tampa, Florida 33607-1462</p> <p>Tel: 813.286.1711 Fax: 813.287.8591</p>	<p>Drawn: W. WEBER</p> <p>Design: GARY WANTLAND</p> <p>Checked: GARY WANTLAND</p> <p>Date: JUNE 20, 2000</p>	<p>PROJECT NAME</p> <p>SOLUTIA INC.</p> <p>SAUGET AREA 1</p> <p>DRAWING TITLE</p> <p>TYPICAL COVER VENT</p>	<p>FIGURE</p> <p>5-3</p>
--	--	--	--

ATTACHMENT 15
REVISED GEOSYNTHETIC CQA MANUAL



CONSTRUCTION QUALITY ASSURANCE MANUAL FOR INSTALLATION OF GEOSYNTHETIC COMPONENTS FOR THE SAUGET AREA 1 TSCA LANDFILL CAHOKIA, ILLINOIS

Prepared for:

Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

Prepared by:

URS

7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462
C100004051.01

December 12, 2000

Revision 1

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1.1 SCOPE

This Construction Quality Assurance (CQA) Manual addresses the quality assurance of the installation of geosynthetic materials used by Solutia Inc. (Solutia) for the construction of the Sauget Area 1 TSCA Landfill located in Cahokia, Illinois.

This manual addresses quality assurance, not quality control. In the context of this manual, quality assurance refers to means and actions employed to assure conformity of the geosynthetic system production and installation with the project-specific, Plans, Specifications, contractual and regulatory requirements. Quality assurance is provided by a party independent from production and installation. Quality control refers only to those actions taken to ensure that materials and workmanship meet the requirements of the Plans and Specifications. Quality control is provided by the manufacturers and installers of the various components of the geosynthetic system.

The scope of this CQA Manual applies to manufacturing, shipment, handling, and installation of geosynthetics. This CQA Manual does not address design guidelines, installation specifications, or selection of geosynthetic materials. It also does not address the quality assurance of soils, except in cases where soil placement may have an influence on the geosynthetics. The quality assurance of soil components of landfill lining and final cover systems is addressed in Solutia's "Quality Assurance Manual for the Installation of Soil Components of the Lining and Final Cover Systems".

1.2 PROJECT ORGANIZATION

Solutia has the overall responsibility for ensuring that all construction activities fulfill the objectives of the project. Solutia will retain an independent construction management firm to coordinate all construction activities of the Feed Pond closure and construction of the TSCA Landfill. Solutia will also retain an independent inspection firm to provide Construction Quality Assurance services during construction activities. Figure 1-1 presents an organization chart for the project.

Key personnel, their authority and responsibilities with respect to the CQA process are as follows:

1.2.1 Solutia Leadership Team

The Solutia Leadership Team will act as a contact with all regulatory agencies for all matters concerning the project and has overall responsibility for the conduct of project activities. The Solutia Leadership Team will ensure that corporate standards are applied during the project and will have the overall responsibility to ensure the project meets all established QA/QC goals. The Solutia Leadership Team is responsible for the coordination between the design firm and Construction Manager and serves as Solutia's representative during construction. They are also the primary point of contact between Solutia and all supporting team members. The Solutia Leadership Team will perform its duties under the direction of Bruce Yare and Mike Light.

1.2.2 Construction Manager

Acting under the authority delegated to him by Solutia, the Construction Manager is the on-site representative and will implement the overall project plans through day-to-day direction of field activities. Solutia will retain a construction management firm to provide these services.

1.2.3 Designer

The Designer is the individual and/or firm responsible for the preparation of the design, including plans and project-specific specifications for the geosynthetic components of the lining and final cover system. The Designer for the TSCA Landfill is URS Corporation Southern (URS).

1.2.4 Geosynthetic Construction Quality Assurance Consultant

The Geosynthetic Construction Quality Assurance (CQA) Consultant is a firm independent from the Construction Manager, Manufacturer(s), and Installer that shall be responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system on behalf of Solutia.

1.2.5 Geosynthetic Quality Assurance Laboratory

The Geosynthetic Quality Assurance Laboratory (QAL) is a firm, independent from the Construction Manager, Manufacturer(s), and Installer, responsible for conducting tests on samples of geosynthetics taken from the site. Solutia will retain an independent laboratory to perform geosynthetic testing for the project.

1.2.6 Construction Contractor(s)

Selected Contractors will be responsible for performing the work outlined in the Plans and Specifications. This work shall include:

- Site mobilization and demobilization
- Site preparation
- Construction of the TSCA Landfill Liner System
- Construction of the TSCA Landfill Cover System

1.3 PROJECT TEAM RESPONSIBILITIES AND QUALIFICATIONS

The parties discussed in this section are associated with the ownership, design, manufacture, transportation, installation, and quality assurance of the geosynthetic system. The qualifications and responsibilities of these parties are outlined in the following subsections.

1.3.1 Construction Manager**1.3.1.1 Responsibilities**

The Construction Manager is responsible for all construction quality. The Construction Manager is responsible for the organization and implementation of the quality assurance activities for the project.

The Construction Manager shall serve as communications coordinator for the project, initiating all construction meetings. As communications coordinator, the Construction Manager shall serve as a liaison between all parties involved in the project to insure that communications are maintained.

The principal responsibilities of the Construction Manager are:

- Establish effective communications with the Solutia Leadership Team and Contractor field representatives, and other project team personnel through correspondence, meetings, and discussions, as required, to maintain close working relationships.
- Execute the project work plans and implement procedures through overall planning and day-to-day direction of field activities.
- Ensure that QA and QC procedures are implemented throughout execution of the work.
- Review Contractor progress reports and payments.
- Issue weekly field activity reports.
- Maintain on-site documentation consisting of procedures, rules and regulations, drawings, survey information, correspondence, meetings, etc.
- Manage and assist other field personnel in overseeing Contractors.

The Construction Manager shall also be responsible for proper resolution of all quality assurance issues that arise during construction.

1.3.1.2 Qualifications

The selection of the Construction Manager is the direct responsibility of Solutia. Qualifications for this position include familiarity with the following:

1. Applicable construction methods and procedures.
2. General geosynthetic lining techniques.
3. All applicable regulatory requirements.
4. Company policies and procedures for project management.
5. Quality assurance requirements.

1.3.2 Designer**1.3.2.1 Responsibilities**

The Designer is responsible for performing the engineering design and preparing the associated Plans and Specifications for the geosynthetic components of the lining and final cover system. The Designer is responsible for approving all design and specification changes and making design clarifications necessitated during construction of the geosynthetic components of the lining and final cover system.

1.3.2.2 Qualifications

The Designer shall be a qualified engineer, certified or licensed as required by regulation. The Designer shall be familiar with geosynthetics (including detailed geosynthetic design methods and procedures) and applicable regulatory requirements.

1.3.2.3 Submittals

The Designer shall submit the project Plans and Specifications to the Solutia Leadership Team and the Construction Manager.

1.3.3 Manufacturer**1.3.3.1 Definitions**

The Manufacturer is a firm responsible for production of any of the various geosynthetic liner system components outlined in the Specifications.

1.3.3.2 Responsibilities

Each Manufacturer is responsible for the production of its geosynthetic product. In addition, each Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Construction Manager after delivery. Each Manufacturer shall produce a consistent product meeting the Specifications. Each Manufacturer shall provide quality control documentation for its product as specified in the Specifications.

1.3.3.3 Qualifications

Each Manufacturer shall be pre-qualified by Solutia. Each Manufacturer shall provide sufficient production capacity and qualified personnel to meet the demands of the project. Each Manufacturer shall have an internal quality control program for its product that meets standard industry requirements.

1.3.3.4 Submittals

Pre-qualification: A Manufacturer shall meet the following requirements and submit the following information:

1. A list of material properties including certified test results, to which are attached geosynthetic samples.
2. The origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture the product.

Pre-installation: Prior to the installation of any geosynthetic material, a Manufacturer must submit to the Construction Manager all quality control documentation required by the Specifications. This documentation shall be reviewed by the Construction Manager before installation can begin.

1.3.4 Installer**1.3.4.1 Definitions**

The Installer is the firm responsible for installation of the geosynthetics. The Installer may be affiliated with the Manufacturer.

The Superintendent is responsible for the Installer's field crew. The Superintendent shall represent the Installer at all site meetings and shall be responsible for acting as the Installer's spokesman on the project.

The Master Seamer shall be the most experienced seamer of the Installer's field crew. The Master Seamer shall provide direct supervision over less experienced seamers.

1.3.4.2 Responsibilities

The Installer shall be responsible for field handling, storing, deploying, seaming, temporary restraining and all other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials from on-site storage to the area of the work.

1.3.4.3 Qualifications

The Installer shall be pre-qualified and approved by Solutia. The Installer shall be able to provide qualified personnel to meet the demands of the project. At a minimum, the Installer shall provide a Superintendent and a Master Seamer as described below.

The Superintendent and Master Seamer must be qualified based on previously demonstrated experience, management ability, and authority.

For geomembrane installation all personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests using the equipment and seaming techniques proposed for this project.

1.3.4.4 Submittals

Pre-qualification: To be considered for pre-qualification, the Installer shall submit the pre-qualification information required by the Specifications.

Pre-installation: Prior to commencement of the installation, the Installer must submit to the Construction Manager:

1. Resume of the Superintendent to be assigned to this project, including dates and duration of employment.
2. Resume of the Master Seamer to be assigned to this project, including dates and duration of employment.
3. A panel layout drawing showing the installation layout identifying field seams as well as any variance or additional details which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.
4. Installation schedule.
5. A list of personnel performing field seaming operations along with pertinent experience information.
6. All geosynthetic quality control certificates as required by this QAM (unless submitted directly to the Construction Manager by the Manufacturer).
7. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

This documentation shall be reviewed by the Construction Manager before installation of the geosynthetic can begin.

Installation: During the installation, the Installer shall be responsible for the submission of:

1. Quality control documentation recorded during installation.
2. Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the Installer.

Completion: Upon completion of the installation, the Installer shall submit:

1. The warranty obtained from the Manufacturer.
2. The installation warranty.

1.3.5 Geosynthetic Construction Quality Assurance Consultant**1.3.5.1 Responsibilities**

The Geosynthetic Construction Quality Assurance (CQA) Consultant is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system. The Geosynthetic CQA Consultant is responsible for implementation of the project CQA Manual and management of the Geosynthetic Quality Assurance Laboratory. The Geosynthetic CQA Consultant is also responsible for issuing a final certification report sealed by a registered professional engineer.

The specific duties of the Geosynthetic CQA Consultant personnel are as follows:

1. Reviews other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.
2. Reviews all changes to design drawings and specifications as issued by the Designer.
3. Attends all quality assurance related meetings.
4. Reviews all Manufacturer and Installer certifications and documentation and makes appropriate recommendations.
5. Reviews the Installer's personnel qualifications for conformance with the qualifications for work on site.
6. Reviews the calibration certification of the on-site tensiometer, if applicable.
7. Notes any on site activities that could result in damage to the geosynthetics.
8. Reports to the Construction Manager, and logs in the daily report.
9. Prepares a daily summary of the quantities of geosynthetics installed that day.
10. Prepares the weekly summary of geosynthetic quality assurance activities.
11. Oversees the marking, packaging and shipping of all laboratory test samples.
12. Reviews the results of laboratory testing and makes appropriate recommendations.
13. Reports any unapproved deviations from the CQA Manual to the Construction Manager.
14. Prepares the final certification report.

1.3.5.2 Qualifications

The Geosynthetic CQA Consultant shall be pre-qualified by Solutia. The Geosynthetic CQA Consultant shall be experienced in quality assurance of geosynthetics. The Geosynthetic CQA Consultant shall be experienced in the preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals.

1.3.5.3 Submittals

Pre-qualification: To be considered for pre-qualification, the Geosynthetic CQA Consultant must provide the following information:

1. Corporate background and information.
2. Quality assurance capabilities:
 - a. A summary of the firm's experience with geosynthetics.
 - b. A summary of the firm's experience in quality assurance, including installation quality assurance of geosynthetics.
 - c. A summary of quality assurance documentation and methods used by the firm, including sample quality assurance forms, reports, certifications, and manuals prepared by the firm.
 - d. Resumes of key personnel.

Pre-installation: Prior to beginning work on a project, the Geosynthetic CQA Consultant must provide the Construction Manager with the following information:

1. Resumes of personnel to be involved in the project.
2. Proof of the required quality assurance experience of all of the quality assurance personnel.

1.3.6 Geosynthetic Quality Assurance Laboratory

1.3.6.1 Responsibilities

The Geosynthetic QAL shall be responsible for conducting the appropriate laboratory tests as directed by the Geosynthetic CQA Consultant or the Construction Manager. The test procedures shall be done in accordance with the test methods outlined in the Plans and Specifications. The Geosynthetic QAL shall be responsible for providing test results.

1.3.6.2 Qualifications

The Geosynthetic QAL shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), and other applicable test standards. The Geosynthetic QAL shall be capable of providing verbal results of destructive seam tests within 24 hours of receipt of test samples and shall maintain that standard throughout the installation. The Geosynthetic QAL shall be approved by Solutia.

On-site laboratory facilities may be used by the Geosynthetic QAL provided they are appropriately equipped and approved by the Geosynthetic QAC and the Construction Manager.

1.3.6.3**Submittals**

Geomembrane destructive test results shall typically be provided verbally to the Construction Manager within 24 hours of receipt of test samples. The Geosynthetic QAL shall submit all destructive seam test results to the Construction Manager in written form within 48 hours of receipt of test samples unless otherwise specified by the Construction Manager. Written test results shall be in an easily readable format and include references to the standard test methods used.

1.4 COMMUNICATION

To guarantee a high degree of quality during installation and assure a final product that meets all project specifications, clear, open channels of communication are essential. This section issues appropriate lines of communication and describes all necessary meetings.

1.4.1 Resolution Meeting

Following the completion of the construction drawings and specifications for the project, a resolution meeting may be held. If a resolution meeting is required, it is recommended that the meeting be held prior to bidding the construction work and include all parties then involved, typically including the Construction Manager, Designer, Geosynthetic CQA Consultant, and a Solutia Leadership Team representative. If necessary, this meeting can be held in conjunction with the pre-construction meeting.

The purpose of this meeting is to establish lines of communication, review construction drawings and specifications for completeness and clarity, begin planning for coordination of tasks, and anticipate any problems which might cause difficulties and delays in construction. All aspects of the design shall be reviewed during this meeting so that clarification and/or design changes may be made before the construction work is bid. In addition, the guidelines regarding quality assurance testing and problem resolution must be known and accepted by all.

A recommended agenda for the resolution meeting is presented in Exhibit 1-1. The meeting shall be documented by the Construction Manager and minutes shall be transmitted to all parties.

1.4.2 Pre-construction Meeting

A pre-construction meeting shall be held at the site prior to beginning geosynthetic deployment. Typically, the meeting shall be attended at a minimum by the Construction Manager, Designer, Installer, and Geosynthetic CQA Consultant.

Specific topics considered for this meeting include review of the project CQA Manual for any problems or additions. In addition, the responsibilities of each party should be reviewed and understood clearly. A recommended agenda with specific topics for the pre-construction meeting is presented in Exhibit 1-2. The meeting shall be documented by the Construction Manager and minutes shall be transmitted to all parties.

1.4.3 Progress Meetings

A progress meeting shall be held at least weekly between the Geosynthetic CQA Consultant, Installer's Superintendent, Construction Manager, and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, issues requiring resolution, and any new business or revisions to the work. The Geosynthetic CQA Consultant shall log any problems, decisions, or questions arising at this meeting in his weekly report. If any matter remains unresolved at the end of this meeting, the Construction Manager shall be responsible for the resolution of the matter and the communication of the decision to the appropriate parties.

2.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geomembrane material, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin suppliers name and resin production plant), identification (brand name and number), and production date of the resin.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geomembrane meets the Specifications.
4. Reports on quality control tests conducted by the Manufacturer to verify that the geomembrane manufactured for the project meets the project specifications.
5. A statement indicating that no reclaimed polymer was added to the resin during manufacturing.
6. A list of the materials with which comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.
7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
8. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be for:
 - a. Density
 - b. Carbon black content
 - c. Carbon black dispersion
 - d. Thickness
 - e. Tensile properties
 - f. Tear resistance

These quality control tests shall be performed in accordance with the frequency and test methods in the Specifications.

The Manufacturer shall identify all rolls of geomembranes with the following:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number

5. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed performance criteria. Measurements of properties by the Manufacturer are properly documented and that test methods used are acceptable.
2. Quality control certificates have been provided at the specified frequency for all rolls and that each certificate identifies the rolls related to it.
3. Rolls are appropriately labeled.
4. Certified minimum properties meet the requirement of the Specifications.

2.2 CONFORMANCE TESTING

Upon delivery of the rolls of geomembrane, the Geosynthetic CQA Consultant shall ensure conformance test samples are obtained for the geomembrane. These samples shall be that forwarded to the Geosynthetic QAL for testing to ensure conformance to the Specifications. If the Construction Manager desires, the Geosynthetic CQA Consultant can direct the conformance sampling be completed at the manufacturing plant.

The following conformance tests shall be conducted:

1. Density
2. Carbon black content
3. Carbon black dispersion
4. Thickness
5. Tensile characteristics
6. Asperity height
7. Interface friction between textured geomembrane/geosynthetic clay liner, smooth geomembrane/geonet, and smooth geomembrane/soil.

These conformance tests shall be performed in accordance with the test frequency and methods in the Specifications.

2.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation manufacturing records.

2.2.2 Liner System Shear Box Testing

Prior to acceptance by the Geosynthetic CQA Consultant or the Construction Manager, the Contractor shall submit information documenting the interface friction values of the selected geosynthetics. Interface friction values shall be determined for the selected material combination provided by the Specifications.

The Construction Manager will review the documentation for conformance with the requirements of the design. This conformance test shall be performed in accordance with the requirements of the Specifications as per ASTM D 5321.

2.2.3 Test Results

All conformance test results shall be reviewed and by the Geosynthetic CQA Consultant prior to the deployment of the geomembrane. The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications. Based upon the recommendation of the Geosynthetic CQA Consultant, the Construction Manager shall accept or reject the geomembrane.

If the Manufacturer has reason to believe that failing tests may be the result of Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failed test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specifications (note that this procedure is valid only when rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

2.3 SUBGRADE PREPARATION**2.3.1 Surface Preparation**

The Earthwork Contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Construction Manager shall coordinate the work of the Earthwork Contractor and the Installer so that the requirements of the Specifications and the project CQA Manual are met.

Before the geomembrane installation begins, the Geosynthetic CQA Consultant shall verify that:

1. A qualified land surveyor has verified all lines and grades.
2. A qualified geotechnical engineer has verified that the supporting soil meets the density specified in the project specifications.
3. The surface to be lined has been rolled, compacted, or handworked so as to be free irregularities, protrusions, loose soil and abrupt changes in grade. Bedding layer soils will have clods no larger than two inches, will be placed and compacted to 90% Standard Proctor Density and will have a moisture content at or optimum. Bedding layers will be smooth with no ruts or sharp edges before, during and after installation of the overlying geosynthetic material. They will provide a surface capable of supporting the geosynthetics and other layers in the liner system.
4. The surface of the supporting soil does not contain stones which may be damaging the geomembrane.
5. There is no area excessively softened by high water content.
6. There is no area where the surface of the soil contains desiccation cracks with dimensions exceeding those allowed by the Specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic CQA Consultant and Construction Manager prior to commencement of geomembrane deployment in the area under consideration.

After the supporting soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Construction Manager any change in the supporting soil condition that may require repair work. The Construction Manager may consult with the Geosynthetic CQA Consultant regarding the need for repairs. The Construction Manager shall ensure that the supporting soil is repaired.

At any time before or during the geomembrane installation, the Geosynthetic CQA Consultant shall indicate to the Construction Manager any locations which may not be adequately prepared for the geomembrane.

2.3.2 Anchor Trench

The Geosynthetic CQA Consultant shall verify that the anchor trench has been constructed according to the design Plans and Specifications.

If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of trench open at any time should be minimized. The Geosynthetic CQA Consultant shall inform the Construction Manager of any signs of significant desiccation associated with the anchor trench construction.

Slightly rounded corners shall be provided in the trench so as to avoid sharp bends in the geomembrane. Excessive amounts of loose soil shall not be allowed to underlie geomembrane in the anchor trench.

The anchor trench shall be adequately drained to prevent ponding or softening of adjacent sods while the trench is open. The anchor trench shall be backfilled and compacted as outlined in the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to geosynthetics. The Geosynthetic CQA Consultant shall observe the backfilling operation and advise the Construction Manager of any problems. Any problems shall be documented by the Geosynthetic CQA Consultant in his daily report.

2.4 GEOMEMBRANE DEPLOYMENT**2.4.1 Panel Nomenclature**

A field panel is defined as a unit of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the Geosynthetic CQA Consultant to ensure that each field panel be given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Construction Manager, Installer and Geosynthetic CQA Consultant. This field panel identification code shall be as simple and logical as possible. In general, it is not appropriate to identify panels using roll numbers since numbers established in the manufacturing plant are usually cumbersome and are related to location in the field. The Geosynthetic CQA Consultant shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

The Geosynthetic CQA Consultant shall verify that field panels are installed at the locations indicated on the Installer's layout plan, as approved by the Construction Manager.

2.4.2 Panel Deployment Procedure

The Geosynthetic CQA Consultant shall review the panel deployment progress of the Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions) and advise the Construction Manager on its compliance with the approved panel layout drawing and its suitability to the actual field conditions. Once approved, only the Construction Manager can authorize changes to the panel deployment procedure. Geosynthetic CQA Consultant shall verify that the condition of the supporting soil does not change detrimentally during installation.

The Geosynthetic CQA Consultant shall record the identification code, location, and date of installation of each field panel.

2.4.3 Deployment Weather Conditions

Geomembrane deployment shall not proceed at an ambient temperature below 32° F (0° C) or above 104° F (40° C) unless otherwise authorized, in writing, by the Construction Manager. Geomembrane placement shall not be performed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The Geosynthetic CQA Consultant shall verify that the above conditions are fulfilled. Ambient temperature shall be measured by the Geosynthetic CQA Consultant in the area in which the panels are to be deployed. The Geosynthetic CQA Consultant shall inform the Construction Manager of any weather related problems which may not allow geomembrane placement to proceed.

2.4.4 Method of Deployment

Before the geomembrane is handled on site, the Geosynthetic CQA Consultant shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the Geosynthetic CQA Consultant shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Geosynthetic CQA Consultant shall verify the following:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.
2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement.
3. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.
4. All personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.
6. The method used to place the panels minimized wrinkles (especially differential wrinkles between adjacent panels).
7. Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind. In case of winds, continuous loading, e.g., by sand bags, is recommended along edges of panel to minimize risk of wind flow under the panels.
8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The Geosynthetic CQA Consultant shall inform the Construction Manager if the above conditions are not fulfilled.

2.4.5 Damage and Effects

Upon delivery to the site, the Geosynthetic CQA Consultant shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Geosynthetic CQA Consultant shall advise the Construction Manager, in writing, of any rolls or portions of rolls which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

The Geosynthetic CQA Consultant shall inspect each panel, after placement and prior to seaming, for damage and/or defects. The Geosynthetic CQA Consultant shall advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetic CQA Consultant. Repairs shall be made using procedures described in the Specifications.

2.4.6 Writing on the Liner

To avoid confusion, the Installer and the Geosynthetic CQA Consultant shall each use different colored markers that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane. The installer shall use a yellow marker to write on the geomembrane. The Geosynthetic CQA Consultant shall use a red marker.

2.5 FIELD SEAMING

2.5.1 Seam Layout

Before installation begins, the Installer must provide the Construction Manager and the Geosynthetic CQA Consultant with a panel layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The Geosynthetic CQA Consultant shall review the panel

layout drawing and verify that it is consistent with accepted state-of-practice. No panels may be seamed without written approval of the panel layout drawing by the Construction Manager. In addition, panels not specifically shown on the panel layout drawing may not be used without the Construction Manager's prior approval.

In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 ft (1.5 m) from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Construction Manager.

A seam numbering system compatible with the panel numbering system shall be used by the Geosynthetic CQA Consultant.

2.5.2 Accepted Seaming Methods

Approved processes for field seaming are extrusion welding and fusion welding. Fusion double seam welding is the preferred method for joining long, straight seams. Extrusion welding is the preferred seaming method in areas such as corners, sumps, pipe penetrations, tear repairs and cap strips where fusion double seam welding is not feasible. Proposed alternate processes shall be documented and submitted by the Installer to the Construction Manager for approval. Only apparatus which have been specifically approved by make and model shall be used. The Construction Manager shall submit all documentation regarding seaming methods to be used to the Geosynthetic CQA Consultant for review.

2.5.2.1 Extrusion Process

The Geosynthetic CQA Consultant shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the construction manager.

The Geosynthetic CQA Consultant shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.
4. Clean and dry welding rods or extrudate pellets are used.
5. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.
6. Grinding shall be completed no more than 1 hour prior to seaming.
7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

8. The geomembrane is protected from damage in heavily trafficked areas.
9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than 1/4-inch from the seamed area.
10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inches (75 mm) for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
11. No solvent or adhesive is used unless the product is approved in writing by the construction manager prior to use (samples shall be submitted to the construction manager for testing and evaluation).
12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged or degraded.

2.5.2.2 Fusion Process

The Geosynthetic CQA Consultant shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the construction manager.

The Geosynthetic CQA Consultant shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. For cross seams, the edge of the cross seam is ground to an incline prior to welding.
4. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.
5. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.
6. The geomembrane is protected from damage in heavily trafficked areas.
7. A movable protective layer is used as required by the installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and prevent debris from collecting around the pressure rollers.
8. In general, the geomembrane panels are aligned to have a nominal overlap of 5 inches (125 mm) for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
9. No solvent or adhesive is used unless the product is approved in writing by the Construction Manager prior to use (samples shall be submitted to the Construction Manager for testing and evaluation).

2.5.3 Seam Preparation

The Geosynthetic CQA Consultant shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Geosynthetic CQA Consultant must ensure that the process is completed according to the manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The Geosynthetic CQA Consultant shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

2.5.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 5 ft (1.0 m) long by 1 ft (0.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 4.6.2.

Two specimens shall be cut from the sample with a 1-inch (25 mm) wide die. The specimens shall be cut by the installer at locations selected randomly along the trial seam sample by the Geosynthetic CQA Consultant. The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute. They should not fail in the seam. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved. The Geosynthetic CQA Consultant shall observe all trial seam procedures.

The remainder of the successful trial seam sample shall be cut into three pieces, one to be retained in the construction manager's archives, one to be given to the installer, and one to be retained by the Geosynthetic CQA Consultant for possible laboratory testing. Each portion of the sample shall be assigned a number and marked accordingly by the Geosynthetic CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

If agreed upon between the Construction Manager and the Geosynthetic CQA Consultant, and documented by the Geosynthetic CQA Consultant in his/her daily report, the remaining portion of the trial seam sample can be subjected to destructive testing. If a trial seam sample fails a test conducted by the Geosynthetic QAL, then a destructive seam test sample shall be taken from each of the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the Geosynthetic QAL and, if they fail the tests, the seam shall be subjected to the "Destructive Test Failure Procedures" identified in this CQA Manual. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

2.5.5 General Seaming Procedures

During general seaming, the Geosynthetic CQA Consultant shall be cognizant of the following:

1. For fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture buildup between the sheets to be welded and prevent debris from collecting around the pressure rollers.
2. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.
3. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches (150 mm) beyond the cut in all directions.
4. If seaming operations are carried out at night, adequate illumination shall be provided.
5. Seaming shall extend to the outside edge of panels placed in the anchor trench.
6. All cross seam tees should be extrusion welded to a minimum distance of 4 inches on each side of the tee.
7. No field seaming shall take place without the master seamer being present.

The Geosynthetic CQA Consultant shall verify that the approved seaming procedures are followed, and shall inform the Construction Manager of any nonconformance.

2.5.6 Seaming Weather Conditions**2.5.6.1 Normal Weather Conditions**

The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32° F (0° C) and 104° F (40° C).
2. Dry conditions (i.e., no precipitation or other excessive moisture, such as fog or dew).
3. No excessive winds.

The Geosynthetic CQA Consultant shall verify that these weather conditions are fulfilled and notify the Construction Manager in writing if they are not. Ambient temperature shall be measured by the Geosynthetic CQA Consultant in the area in which the panels are to be placed. The Construction Manager will then decide if the installation is to be stopped or special procedures used.

2.5.6.2 Cold Weather Conditions

To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32° F (0° C), the following conditions must be met:

1. Geomembrane surface temperatures shall be determined by the Geosynthetic CQA Consultant at intervals of at least once per 100 foot of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32° F (0° C).
2. Preheating may be waived by the construction manager based on a recommendation from the Geosynthetic CQA Consultant, if the installer demonstrates to the Geosynthetic CQA Consultant's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
3. If preheating is required, the Geosynthetic CQA Consultant shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.
4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.
5. All preheating devices shall be approved prior to use by the construction manager.
6. Additional destructive tests shall be taken at an interval between 500 and 250 feet of seam length, at the discretion of the Geosynthetic CQA Consultant.
7. Sheet grinding may be performed before preheating, if applicable.
8. Trial seaming shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 5° F from the initial trial seam test conditions.

2.5.6.3 Warm Weather Conditions

At ambient temperatures above 104° F, no seaming of the geomembrane shall be permitted unless the installer can demonstrate to the satisfaction of the construction manager that geomembrane seam quality is not compromised.

Trial seaming shall be conducted under the same ambient temperature conditions as the actual seams.

At the option of the Geosynthetic CQA Consultant, additional destructive tests may be required for any suspect areas.

2.6 NONDESTRUCTIVE SEAM TESTING**2.6.1 Concept**

The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

For all seams, the Geosynthetic CQA Consultant shall:

1. Observe nondestructive testing procedures.
2. Record location, data, test unit number, name of tester, and outcome of all testing.
3. Inform the Installer and Construction Manager of any required repairs.

Any seam that cannot be nondestructively tested shall be cap-stripped with the same geomembrane. The cap-stripping operations shall be observed by the Geosynthetic CQA Consultant and Installer for uniformity and completeness.

2.6.2 Vacuum Testing

The following procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:
 - a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
 - b. A pump assembly equipped with a pressure controller and pipe connections.
 - c. A rubber pressure/vacuum hose with fittings and connections.
 - d. A soapy solution.
 - e. A bucket and wide paint brush, or other means of applying the soapy solution.
2. The following procedures shall be followed:
 - a. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi (10 in. of Hg) (35 kPa) gauge.
 - b. Wet a strip of geomembrane approximately 12 inches x 48 inches (0.3 m x 1.2 m) with the soapy solution.
 - c. Place the box over the wetted area.
 - d. Close the bleed valve and open the vacuum valve.

- e. Ensure that a leak-tight seal is created.
- f. For a period of not less than 10 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.
- g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process.
- h. All areas where soap bubbles appear shall be marked and repaired.

2.6.3 Air Pressure Testing

The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:
 - a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.
 - b. A rubber hose with fittings and connections.
 - c. A sharp hollow needle, or other approved pressure feed device.
2. The following procedures shall be followed:
 - a. Seal both ends of the seam to be tested.
 - b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
 - c. Insert a protective cushion between the air pump and the geomembrane.
 - d. Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.
 - e. If loss of pressure exceeds 4 psi (30 kPa) or does not stabilize, locate faulty area and repair in accordance with Section 4.9.3.
 - f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seal the cut end of the air channel.
 - g. Remove needle or other approved pressure feed device and seal.

2.6.4 Test Failure Procedure

The Installer shall complete any required repairs in accordance with the requirements of the Specifications. For repairs, the Geosynthetic CQA Consultant shall:

1. Observe the repair and testing of the repair.
2. Mark on the geomembrane that the repair has been made.
3. Document the repair procedures and test results.

2.7 DESTRUCTIVE SEAM TESTING

2.7.1 Concept

Destructive seam tests shall be performed at selected locations in accordance with the requirements of the Specifications. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

2.7.2 Location and Frequency

The Geosynthetic CQA Consultant shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

1. A minimum frequency of one test location per 500 ft (150 m) of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire facility.
2. Test locations shall be determined during seaming at the Geosynthetic CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of overheating, contamination, offset welds, or any other potential cause of imperfect welding.
3. One additional CQA destructive seam test will be performed for every 10 destructive tests required by the specifications with a minimum of two CQA destructive tests per geomembrane layer.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

2.7.3 Sampling Procedures

Samples shall be cut by the Installer at locations chosen by the Geosynthetic CQA Consultant as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Geosynthetic CQA Consultant shall:

1. Observe sample cutting.
2. Assign a number to each sample, and mark it accordingly.
3. Record sample location on layout drawing.
4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in the Specification. The continuity of the new seams in the repaired area shall be tested.

2.7.4 Sample Dimensions

At a given sampling location, two types of samples shall be taken by the Installer. First, two samples for field testing should be taken. Each of these samples shall be cut with a 1-inch (25 mm) wide die, with the seam centered parallel to the width. The distance between these two samples shall be 42 inches (1.1 m). If both samples pass the field test described in Section 4.8.5, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches (0.3 m) wide by 42 inches (1.1 m) long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for optional laboratory testing, 12 inches x 12 inches (0.3 m x 0.3 m)
2. One portion for Geosynthetic QAL testing, 12 inches x 18 inches (0.3 m x 0.5 m) and
3. One portion to the Construction Manager for archive storage, 12 inches x 12 inches (0.3 m x 0.3 m).

Final determination of the sample sizes shall be made at the pre-construction meeting.

2.7.5 Field Testing

The two 1-inch (25 mm) wide strips shall be tested in the field using a tensiometer for peel and shall not fail according to the criteria in the Specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of 2 in. per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired. Final judgement regarding seam acceptability, based on the failure criteria shall be made by the Construction Manager.

The Geosynthetic CQA Consultant shall witness all field tests and mark all samples and portions with their number. The Geosynthetic CQA Consultant shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

2.7.6 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetic CQA Consultant in a manner which will not damage the test sample. The

Construction Manager will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include "seam strength" and "peel adhesion". These terms are defined in the specifications. The minimum acceptable values to be obtained in these tests are indicated in the Specifications. At least 5 specimens shall be tested in each shear and peel. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear...). A passing test shall meet the minimum acceptable values in at least 4 of the 5 specimens tested for each method.

The Geosynthetic QAL shall provide verbal test results no more than 24 hours after they receive the samples. The Geosynthetic CQA Consultant shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Construction Manager.

2.7.7 Destructive Test Failure Procedures

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL, or by field tensiometer. The Installer has two options:

1. The Installer can repair the seam between any two passing test locations.
2. The Installer can trace the welding path to an intermediate location (at 10 ft (3 m) minimum from the point of the failed test in each direction) and take a sample with a 1 in. (25 mm) wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 4.6.4 may be used as a boundary for the failing seam. In cases exceeding 150 ft (50 m) of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Specifications.

The Geosynthetic CQA Consultant shall document all actions taken in conjunction with destructive test failures.

2.8 DEFECTS AND REPAIRS

2.8.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the Geosynthetic CQA Consultant for identification of defects, holes, busters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the installer if the amount of dust or mud inhibits examination.

2.8.2 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in the Specifications as appropriate. Each location which fails the nondestructive testing shall be marked by the Geosynthetic CQA Consultant and repaired by the installer. Work shall not proceed with any materials which will cover locations which have been repaired until appropriate nondestructive and laboratory test results with passing values are available.

2.8.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Construction Manager, Installer, and Geosynthetic CQA Consultant.

1. The repair procedures available include:
 - a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
 - b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized flaws.
 - c. Capping, used to repair large lengths of failed seams.
 - d. Extrusion welding the flap, used to repair areas of inadequate fusion seams, which have an exposed edge. Repairs of this type shall be approved by the Geosynthetic CQA Consultant, and shall not exceed 50 ft (15 m) in length.
 - e. Removing bad seam and replacing with a strip of new material welded into place.
2. For any repair method, the following provisions shall be satisfied:
 - a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
 - b. All surfaces shall be clean and dry at the time of the repair.
 - c. All seaming equipment used in repairing procedures shall meet the requirements of the project CQA Manual.
 - d. Patches or caps shall extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches (75 mm).

2.8.4 Repair Verification

Each repair shall be numbered and logged. Each repair shall be nondestructively tested using the methods described in the Specifications as appropriate. Repairs which pass the nondestructive

test shall be taken as an indication of an adequate repair. Repairs more than 150 ft long may be of sufficient extent to require destructive test sampling, at the discretion of the Geosynthetic CQA Consultant. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Geosynthetic CQA Consultant shall observe all nondestructive testing of repairs and shall record the number of each repair, date, and test outcome.

2.8.5 Large Wrinkles

When seaming of the geomembrane is completed, and prior to placing overlying materials, the Geosynthetic CQA Consultant shall indicate to the Construction Manager which wrinkles should be cut and resealed by the Installer. The number of wrinkles to be repaired should be, kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation process, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. The geomembrane will be inspected for wrinkles every morning by the Geosynthetic CQA Consultant and the results of the inspection will be documented. On completion of geomembrane installation, it will be inspected for wrinkles by the Geosynthetic CQA Consultant and the Agency and the results of this inspection will be video recorded with a date stamp. Unacceptably large wrinkles will be removed after this final inspection. Wrinkles are considered to be large when the geomembrane can be folded over on to itself. Seams produced while repairing wrinkles shall be tested as outlined above.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Geosynthetic CQA Consultant to ensure that wrinkle formation is minimized.

2.9 GEOMEMBRANE PROTECTION

The quality assurance procedures indicated in this section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality assurance of the adjacent materials themselves should be covered in separate sections of the project CQA Manual as necessary.

2.9.1 Soils

A copy of the specifications prepared by the designer for placement of soils shall be given to the Geosynthetic CQA Consultant by the Construction Manager. The Geosynthetic CQA Consultant shall verify that these specifications are consistent with the state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32° F (0° C) nor above 104° F (40° C) unless otherwise specified.
2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. A geotextile or other cushion approved by the designer is generally required between aggregate and the geomembrane.
4. Equipment used for placing soil shall not be driven directly on the geomembrane.
5. A minimum thickness of 1 ft (0.3 m) of soil is specified between a light dozer (ground pressure of 5 psi (35 kPa) or lighter) and the geomembrane.
6. In any areas traversed by any vehicles other than low ground pressure vehicles approved by the Construction Manager, the soil layer shall have a minimum thickness of 3 ft (0.9 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The Geosynthetic CQA Consultant shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetic CQA Consultant must also verify that final thicknesses are consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The Geosynthetic CQA Consultant shall inform the Construction Manager if the above conditions are not fulfilled.

3.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geotextile, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on quality control tests conducted by the Manufacturer to verify that the geotextile manufactured for the project meets the project specifications.
4. A specification for the geotextile which includes all properties contained in the project specifications measured using the appropriate test methods.
5. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.
6. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.
7. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for:
 - a. Mass per unit area
 - b. Grab strength
 - c. Trapezoidal tear strength
 - d. Burst strength
 - e. Puncture strength
 - f. Thickness

Quality control tests shall be performed in accordance with the frequency and test methods identified in the project Specifications.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum average roll properties meet the project specifications.

3.2 CONFORMANCE TESTING

Upon delivery of the rolls of geotextiles, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the geotextile. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the project specifications.

At a minimum, the following conformance tests shall generally be performed on geotextiles:

1. Mass per unit area
2. Grab strength
3. Trapezoidal tear strength
4. Burst strength
5. Puncture strength
6. Thickness

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

3.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first complete revolution of fabric on the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

3.2.2 Test Results

All conformance test results shall be reviewed by the Geosynthetic CQA Consultant prior to the deployment of the geotextile. The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project Specifications. Based upon the recommendations of the Geosynthetic CQA Consultant, the Construction Manager shall accept or reject the geotextile.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

3.3 GEOTEXTILE DEPLOYMENT

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Geosynthetic CQA Consultant shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Construction Manager.

The Installer shall handle all geotextiles in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.
6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

3.4 SEAMING PROCEDURES

On slopes steeper than 10 (horizontal):1 (vertical), all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches (75 mm) prior to seaming. In general, no horizontal seam shall be allowed on side slopes (i.e., seams shall be along, not across, the slope), except as part of a patch.

On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Construction Manager.

The Installer shall pay particular attention at seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the Construction Manager and the Geosynthetic CQA Consultant.

3.5 DEFECTS AND REPAIRS

Any holes or tears in the geotextile shall be repaired as follows:

1. On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.
2. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.
3. The Geosynthetic CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Construction Manager.

3.6 GEOTEXTILE PROTECTION

All soil materials located on top of a geotextile shall be deployed in such a manner as to ensure:

1. The geotextile and underlying lining materials are not damaged.
2. Minimal slippage of the geotextile on underlying layers occurs.
3. No excess tensile stresses occur in the geotextile.

Any noncompliance shall be noted by the Geosynthetic CQA Consultant and reported to the Construction Manager. If portions of the geotextile are exposed, the Geosynthetic CQA Consultant may periodically place two (or more, at his discretion) marks on the geotextile 10 ft (3 m) apart along the slope and measure the elongation of the geotextile during the placement of soil. This data shall be reported to the Construction Manager.

4.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geonet, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name and number), and production date of the resin.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geonet meets the Specifications.
4. Reports on quality control tests conducted by the Manufacturer to verify that the geonet manufactured for the project meets the project specifications.
5. A list of the materials which comprise the geonet expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.
6. A specification for the geonet which includes all properties contained in the Specifications measured using the appropriate test methods.
7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
8. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for:
 - a. Density
 - b. Mass per unit area
 - c. Thickness
 - d. Carbon black content
 - e. Transmissivity

Quality control tests shall be performed in accordance with the frequency and test methods identified in the Specifications.

The Manufacturer shall identify all rolls of geonets with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum properties meet the Specifications.

4.2 CONFORMANCE TESTING

Upon delivery of the rolls of geonet, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the geonet. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the Specifications.

At a minimum, the following tests shall be performed:

1. Density
2. Mass per unit area
3. Thickness
4. Interface friction between geomembrane/geonet.
5. Transmissivity

These conformance tests shall be performed in accordance with the test methods specified in the Solutia specifications. Other conformance tests required by the project specifications shall be performed.

4.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

4.2.2 Test Results

All conformance test results shall be reviewed and by the Geosynthetic CQA Consultant prior to the deployment of the geonet. The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications. Based upon the recommendations of the Geosynthetic CQA Consultant the Construction Manager will accept or reject the geonet.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

4.3 GEONET DEPLOYMENT

The Geosynthetic CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Construction Manager.

Geonet cleanliness is essential to its performance. Therefore, the geonet rolls should be protected against dust and dirt during shipment and storage.

The Geosynthetic CQA Consultant shall verify that the geonet is free of dirt and dust prior to installation. The Geosynthetic CQA Consultant shall report the outcome of this verification to the Construction Manager, and if the geonet is judged dirty or dusty, it shall be washed by the Installer prior to installation. Washing operations shall be observed by the Geosynthetic CQA Consultant and improper washing operations shall be reported to the Construction Manager.

The Installer shall handle all geonet in such a manner as to ensure that it is not damaged in any way, and the following shall be complied with:

1. On slopes, the geonet shall be secured and rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles.
2. In the presence of wind, all geonet shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Unless otherwise specified, geonet shall not be welded to geomembrane.
4. Geonet shall only be cut using scissors or other cutting tools approved by the Construction Manager that will not damage the underlying geosynthetics. Care shall be taken not to leave tools in the geonet.
5. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geonet.
6. During placement of geonet, care shall be taken not to entrap in the geonet dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, it should be hosed clean prior to placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags, to prevent rupture or damage of the sandbag.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

4.4 SEAMS AND OVERLAPS

Adjacent geonet shall be joined according to construction drawings and specifications. At a minimum, the following requirements shall be met:

1. Adjacent rolls shall be overlapped by at least 4 inches (100 mm).
2. Overlaps shall be secured by tying.
3. Tying can be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
4. Tying shall be every 5 ft (1.5 m) along the slope, every 6 inches (0.15 m) in the anchor trench, and every 6 inches (0.15 m) along end-to-end seams on the base of the landfill.
5. In general, no horizontal seams shall be allowed on side slopes.
6. In the corners of the side slopes of rectangular landfills, where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonet, from top to bottom of the slope.
7. When more than one layer of geonet is installed, joints shall be staggered.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

When several layers of geonet are stacked, care shall be taken to prevent strands of one layer from penetrating the channels of the next layer, thereby significantly reducing the transmissivity. This cannot happen if stacked geonet are placed in the same direction.

4.5 DEFECTS AND REPAIRS

Any holes or tears in the geonet shall be repaired by placing a patch extending 1 ft (0.3 m) beyond the edges of the hole or tear. The patch shall be secured to the original geonet by tying every 6 inches (0.15 m). Tying devices shall be as indicated in the Specifications. If the hole or tear width across the roll is more than 50% of the width of the roll, the damaged area shall be repaired as follows:

1. On the base of the landfill, the damaged area shall be cut out and the two portions of the geonet shall be joined as indicated in the Specifications.
2. On sideslopes, the damaged geonet shall be removed and replaced.

The Geosynthetic CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Construction Manager.

4.6 GEONET PROTECTION

Soil should never be placed in direct contact with geonet. Soil materials near the geonet shall be placed in such a manner as to ensure:

1. The geonet and underlying lining materials are not damaged.
2. Minimal slippage of the geonet on underlying layers occurs.
3. No excess tensile stresses occur in the geonet.

Any noncompliance shall be noted by the Geosynthetic CQA Consultant and reported to the Construction Manager.

5.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geogrid, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name and number), and production date of the resin.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geogrid meets the Specifications.
4. Reports on quality control tests conducted by the Manufacturer to verify that the geogrid manufactured for the project meets the project specifications.
5. A list of the materials which comprise the geogrid, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.
6. A specification for the geogrid which includes all properties contained in the project specifications measured using the appropriate test methods.
7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
8. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for:
 - a. Mass per unit area
 - b. Measurement of spacing between strands
 - c. Wide strip tensile strength
 - d. Node strength

Quality control tests shall be performed in accordance with the frequency and test methods specified in the Specifications.

The Manufacturer shall identify all rolls of geogrids with the following:

- a. Manufacturer's name
- b. Product identification
- c. Roll number
- d. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurement of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum properties meet the Specifications.

5.2 CONFORMANCE TESTING

Upon delivery of the rolls of geogrid, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the geogrid. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the project specifications.

At a minimum, the following conformance tests shall be performed on geogrid:

1. Mass per unit area
2. Measurement of spacing between strands
3. Wide strip tensile strength
4. Node strength

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

5.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

5.2.2 Test Results

All conformance test results must be reviewed and accepted or rejected by the Geosynthetic CQA Consultant prior to the deployment of the geogrid.

The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the minimum property values listed in project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test shall be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

5.3 GEOGRID DEPLOYMENT

The Installer shall handle all geogrid in such a manner as to ensure it is not damaged in any way, and the following shall be complied with:

1. On slopes, the geogrid shall be secured and rolled down the slope in such a manner as to continually keep the geogrid in tension.
2. In the presence of wind, all geogrids shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Geogrid shall be cut using scissors only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geogrid.
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geogrid.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

5.4 SEAMS AND OVERLAPS

The geogrid, where used, shall be placed in continuous pieces downslope. No lateral joining is required. Edge to edge placement shall be sufficient.

Where geogrid is joined end to end, a splice approved by the manufacturer shall be used. The splice shall not have any metallic components.

5.5 REPAIRS

Any damaged roll of geogrid shall be discarded. No repairs shall be allowed.

5.6 SOIL MATERIALS PLACEMENT

All soil materials located on top of a geogrid shall be deployed in such a manner as to ensure:

1. The geogrid and underlying materials are not damaged.
2. Minimal slippage of the geogrid on underlying layers occurs.

Any noncompliance shall be noted by the Geosynthetic CQA Consultant and reported to the Construction Manager.

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum properties meet the Specifications.

6.2 CONFORMANCE TESTING

Upon delivery of the rolls of GCL, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the GCL. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the Specifications.

At a minimum, the following tests shall be performed:

1. Swell Index
2. Mass per unit area
3. Thickness
4. Permeability
5. Interface friction between geosynthetic clay liner/soil as well as the textured geomembrane/geosynthetic clay liner conformance test identified in Section 2.2.

These conformance tests shall be performed in accordance with the test methods specified in the Solutia specifications. Other conformance tests required by the project specifications shall be performed.

6.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

6.2.2 Test Results

All conformance test results shall be reviewed and by the Geosynthetic CQA Consultant prior to the deployment of the GCL. The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications. Based upon the recommendations of the Geosynthetic CQA Consultant the Construction Manager will accept or reject the GCL.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

6.3 GCL DEPLOYMENT

The Geosynthetic CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Construction Manager.

The Installer shall handle all GCL in such a manner as to ensure that it is not damaged in any way, and the following shall be complied with:

1. On slopes, the GCL shall be secured and rolled down the slope in such a manner as to continually keep the GCL sheet in tension. If necessary, the GCL shall be positioned by hand after being unrolled to minimize wrinkles.
2. In the presence of wind, all GCL shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Unless otherwise specified, GCL shall not be welded to geomembrane.
4. GCL shall only be cut using scissors or other cutting tools approved by the Construction Manager that will not damage the underlying geosynthetics. Care shall be taken not to leave tools in the GCL.
5. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the GCL.
6. During placement of GCL, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. In this regard, care shall be taken with the handling of sandbags, to prevent rupture or damage of the sandbag.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

6.4 SEAMS AND OVERLAPS

Adjacent GCL shall be joined according to construction drawings and specifications. At a minimum, the following requirements shall be met:

1. Adjacent rolls shall be overlapped by at least 4 inches (100 mm).
2. In general, no horizontal seams shall be allowed on side slopes.
3. In the corners of the side slopes of rectangular landfills, where overlaps between perpendicular GCL strips are required, an extra layer of GCL shall be unrolled along the slope, on top of the previously installed GCL, from top to bottom of the slope.
4. When more than one layer of GCL is installed, joints shall be staggered.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

6.5 DEFECTS AND REPAIRS

Any holes or tears in the GCL shall be repaired by placing a patch extending 1 ft (0.3 m) beyond the edges of the hole or tear. If the hole or tear width across the roll is more than 50% of the width of the roll, the damaged area shall be repaired as follows:

1. On the base of the landfill, the damaged area shall be cut out and the two portions of the GCL shall be joined as indicated in the Specifications.
2. On sideslopes, the damaged GCL shall be removed and replaced.

The Geosynthetic CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Construction Manager.

SECTION SEVEN

LINING SYSTEM ACCEPTANCE

Upon written recommendation by the Geosynthetic CQA Consultant, the Construction Manager shall consider accepting the geosynthetic lining system. The conditions of acceptance are described below. The Installer and Manufacturer(s) will retain all ownership and responsibility for the geosynthetics in the lining and final cover system until acceptance by Solutia. At Solutia's discretion, the geosynthetic-lining system may be accepted in sections at points of substantial completion or upon completion of all work.

The geosynthetic lining system will be accepted by Solutia when:

1. The installation of the lining and cover system or section thereof, is finished.
2. Verification of the adequacy of all seams and repairs, including associated testing, is completed.
3. All documentation of installation is completed.
4. The Geosynthetic CQA Consultant is able to recommend acceptance.

The Geosynthetic CQA Consultant shall certify that installation has proceeded in accordance with the requirement of the Plans and Specifications except as noted to the Construction Manager. This certification shall be provided in the final certification report.

An effective CQA Manual depends largely on identification of all construction activities that shall be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The Geosynthetic CQA Consultant shall document that all requirements in the geosynthetic portions of the project have been addressed and satisfied.

The Geosynthetic CQA Consultant shall provide the Construction Manager with signed descriptive remarks, data sheets, and checklists to verify that all monitoring activities have been carried out. The Geosynthetic CQA Consultant shall also maintain at the job site a complete file of all documents which comprise the CQA Manual, including Plans and Specifications, checklists, test procedures, daily logs, and other pertinent documents.

8.1 DAILY REPORTS

Each on-site representative of the Geosynthetic CQA Consultant shall complete a daily report and/or logs on prescribed forms, outlining all monitoring activities for that day. The precise areas, panel numbers, seams completed and approved, and measures taken to protect unfinished areas overnight shall be identified. Failed seams or other panel areas requiring remedial action shall be identified with regard to nature of action, required repair, and precise location. Repairs completed must also be identified. Any problems or concerns with regard to operations on site should also be noted. Any matters requiring action by the Construction Manager shall be identified. The report shall include a summary of the quantities of all geosynthetics installed that day.

This report must be completed daily, and submitted to the Construction Manager at the beginning of the work day following the report date.

8.2 DESTRUCTIVE TESTING REPORTS

The destructive test reports from all sources shall be collated by the Geosynthetic CQA Consultant. This includes field tests, Installers laboratory tests (if performed), and Geosynthetic QAL tests. A summary list of test sample pass/fail results shall be prepared by the Geosynthetic CQA Consultant on an ongoing basis, and submitted with the weekly progress reports.

8.3 PROGRESS REPORTS

Progress reports shall be prepared by the Geosynthetic CQA Consultant and submitted to the Construction Manager. These reports shall be submitted every week, starting the first Friday of geosynthetics deployment on site. This report shall include: an overview of progress to date; an outline of any changes made to the Plans or Specifications, any problems or deficiencies in installation at the site, and an outline of any action taken to remedy the situation(s); a summary of weather conditions; and a brief description of activities anticipated for the next reporting period.

All geosynthetics CQA Consultant daily reports for the period should be appended to each progress report.

8.4 AS-BUILT DRAWINGS

As-built drawings shall be prepared by the Geosynthetic CQA Consultant. The as-built drawings shall include, at a minimum, the following information for geomembranes:

1. Dimensions of all geomembrane field panels.
2. Location, as accurate as possible, of each panel relative to the site survey grid (furnished by the Construction Manager).
3. Identification of all seams and panels with appropriate numbers or identification codes (see Section 4.5.1).
4. Location of all patches and repairs.
5. Location of all destructive testing samples.

Information collected during installation of the geosynthetic materials shall be compiled in the field while construction is in progress. Upon completion of a layer or component of the landfill (e.g. primary geomembrane liner) a draft copy of the compiled as built drawing and construction data shall be submitted to the Construction Manager.

The as-built drawings shall illustrate each layer of geomembrane, and, if necessary, another drawing shall identify problems or unusual conditions of the geotextile or geonet layers. In addition, applicable cross-sections shall show layouts of geonets, geotextiles or geogrids in sump areas or any other areas which are unusual or differ from the design Plans.

8.5 FINAL CERTIFICATION REPORT

A final certification report shall be submitted upon completion of the work. This report shall summarize the activities of the project, and document all aspects of the quality assurance program performed.

The final certification report shall include, at a minimum, the following information:

1. Parties and personnel involved with the project
2. Scope of work
3. Outline of project
4. Quality assurance methods
5. Test results (conformance, destructive and non-destructive, including laboratory tests)
6. Certification, sealed and signed by a registered Professional Engineer
7. As-built drawings, sealed and signed by a registered professional engineer

The Geosynthetic CQA Consultant shall certify in the report that the installation has proceeded in accordance with the project Plans and Specifications except as noted to the Construction Manager. A recommended outline for the final certification report is given in Exhibit 2-1. At

the direction of the Construction Manager this final certification report may be combined with the certification report for the soil components of the lining and final cover system.

TABLER

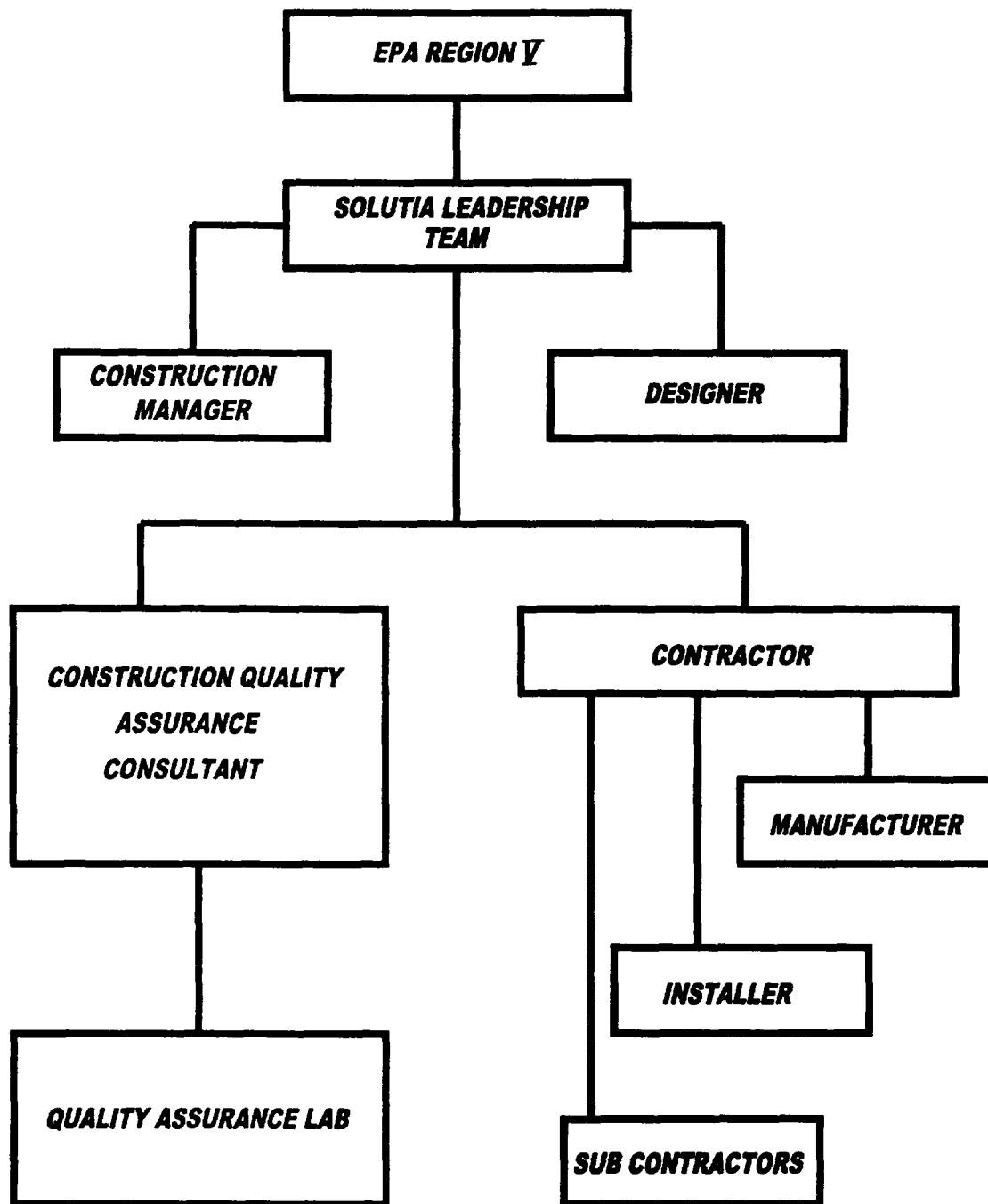
**GEOSYNTHETIC MATERIAL PROPERTIES
SAUGET AREA 1 TSCA LANDFILL
SOLUTIA INC.
CAHOKIA, ILLINOIS**

URS

Material Type	Property	Test Method	Requirements		Frequency
			Value	Units	
	UV Resistance	GM 11			Per Batch
	(a) Standard OIT (min. ave.)	ASTM D 3895	Not Recommend	N/A	
	-or- (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs	ASTM D 5885	50	%	
<u>Geotextile</u>					
	Mass per Area	ASTM D 5261	16	oz/yd ²	
	Grab Strength	ASTM D 4632	380	lbs	
	Elongation	ASTM D 4632	60	%	
	AOS	ASTM D 4751	100	U.S. Sieve	
	Permittivity	ASTM D 4491	0.7	sec ⁻¹	
	Trapezoidal Tear Strength	ASTM D 4533	145	lbs	
	Burst Strength	ASTM D 3786	750	psi	
	Puncture Strength	ASTM D 4833	240	lbs	
<u>Geonet</u>					Per Batch
	Density	ASTM D 792 or D 1505	0.90 min.	g/cu cm	
	Thickness	ASTM D 5199	200 min.	mils	
	Melt Flow Index	ASTM D 1238	1.0 max.	g/10 min.	
	Carbon Black Content	ASTM D 1603	2-3 range	%	
	Tensile Strength at Break:				
	• Machine Direction	ASTM D 751	25 min.	ppi	
	• Cross Direction	ASTM D 751	15 min.	ppi	

Material Type	Property	Test Method	Requirements		Frequency
			Value	Units	
	Transmissivity	ASTM D 4716	1.0	cm/sec	
<u>Geosynthetic Clay Liner</u>	Bentonite Content @ 20% Moisture Content	Weigh 12" x Roll Width	1.0	lbs/sq ft	1/20,000 sf
	Confined Swell	GRI-GCL-1	150	%	1/300,000 sf
	Permeability under 5 psi effective confining pressure	ASTM D 5084	5×10^{-9}	cm/sec	1/1,000,000 sf
	Overlap Seam Permeability under psi effective confining pressure	ASTM D 5084	5×10^{-9}	cm/sec	1/1,000,000 sf
	Grab Strength	ASTM D 4632	150	lbs	1/200,000 ft ²
	Hydrated Internal Residual Shear Resistance	ASTM D 5321	10	degrees	Periodic
	Hydrated Internal Residual Shear Resistance	ASTM D 532	16	degrees	Periodic

FIGURES



1.DWG 11/03/00 15:56

U:\PROJETS\SAU

PREPARED FOR: SOLUTIA

ORSGWC JOB NUMBER: C100003899.00

URS Greiner Woodward Clyde

A Division of URS Corporation
7850 W. Courtney Campbell Causeway
Tampa, Florida 33607-1462
Tel: 813.286.1711 Fax: 813.287.8591

Drawn:

Design:

Checked: G. WANTLAND

Date: OCT. 30, 2000

PROJECT NAME

SOLUTIA INC.
SAUGET AREA 1

DRAWING TITLE

CONSTRUCTION QUALITY ASSURANCE PROTECT
ORGANIZATION CHART

FIGURE

1-1

EXHIBITS

EXHIBIT 1-1
RESOLUTION MEETING AGENDA

SAUGET AREA 1
SOLUTIA INC.
CAHOKIA, ILLINOIS

1. Introductions
 - A. Assign Minute Taker
 - B. Identify Parties
 1. Construction Manager
 2. Designer
 3. Geosynthetic Quality Assurance Consultant
 4. Solutia representative
 5. Others
2. Distribution of Documents
 - A. Design and Construction Drawings
 - B. Specifications
 - C. Construction Quality Assurance (CQA) Manuals
 - D. Permit Documents
3. Review Construction Plans and Specifications
4. Review Geosynthetic CQA Manual
5. Tour Project Site
6. Contract Administration and Construction Issues
7. Define Lines of Communication
8. Project Deliverables
9. Schedule

EXHIBIT 1-2

PRE-CONSTRUCTION MEETING AGENDA

SAUGET AREA 1 SOLUTIA INC. CAHOKIA, ILLINOIS

1. Introductions
 - A. Assign Minute Taker
 - B. Identify Parties
 1. Construction Manager
 2. Construction Contractor
 3. Geosynthetic Construction Quality Assurance Consultant
 4. Installer
 5. Designer
 6. Solutia Representative
2. Distribution of Documents
 - A. Construction Plans and Specifications
 - B. Geosynthetic Panel Layout
 - C. Geosynthetic Construction Quality Assurance Manual
3. Lines of Communication
 - A. Reporting Methods
 - B. Progress Meetings
 - C. Procedures for Approving Design Clarifications and Changes During Construction
4. Tour Project Site
5. Site Requirements
 - A. Safety Rules
 - B. Site Rules
 - C. Work Schedule
 - D. Storage of Materials
 - E. Available Facilities

EXHIBIT 1-2

PRE-CONSTRUCTION MEETING AGENDA

SAUGET AREA 1 SOLUTIA INC. CAHOKIA, ILLINOIS (Continued)

- 6. Construction Issues
 - A. Scope of Work
 - B. Review Plans and Specifications
 - 1. Design and Construction Requirements
 - 2. Geosynthetic Panel Layout
 - C. Review Construction Procedures
 - 1. Proposed Construction Sequencing
 - 2. Equipment
 - D. Review Construction Schedule
 - E. Review Procedures for Preparing and Approving Change Orders
- 7. Discuss Construction Quality Assurance Plan
 - A. Soils
 - B. Geosynthetics
 - C. Structural Systems (e.g., risers, piping, etc.)
- 8. Project Deliverables
 - A. Responsibilities
 - 1. Construction Manager
 - 2. Designer
 - 3. Installer
 - 4. Geosynthetic Construction Quality Assurance Consultant
 - B. Distribution of Deliverables
 - C. Approval Procedures

EXHIBIT 2-1

FINAL CONSTRUCTION QUALITY ASSURANCE CERTIFICATION REPORT GENERAL OUTLINE

SAUGET AREA 1 SOLUTIA INC. CAHOKIA, ILLINOIS

1. Introduction
 - Purpose
 - Scope
 - Unit Description
2. Project Specifications
 - Scope
 - Design Changes
3. Quality Assurance Plan
 - Scope
 - Project-Specific Addenda
4. Quality Assurance Work Performed
 - Weather Constraints
 - Conformance Testing
 - Visual Monitoring
 - Nondestructive Testing
 - Destructive Testing
 - Repairs
5. Summary and Conclusions
6. Project Certification
7. Appendices
 - Geosynthetic and/or Soils QAC Personnel
 - Contractor Personnel
 - Quality Assurance Plan (QAP) and Specification Modifications
 - Design Change Forms

EXHIBIT 2-1

FINAL CONSTRUCTION QUALITY ASSURANCE CERTIFICATION REPORT GENERAL OUTLINE

SAUGET AREA 1 SOLUTIA INC. CAHOKIA, ILLINOIS (Continued)

- Earthwork Testing Records (if required)
- Conformance Testing Records
- Manufacturer Quality Control Records
- Quality Assurance Reports
- Subgrade Acceptance Certificates Panel Placement Records
- Destructive Seam Testing Records Destructive Seam Testing Records Repairs
- As-Built Drawings

APPENDIX A

**EXAMPLES OF GEOSYNTHETIC QUALITY
ASSURANCE DOCUMENTATION**

PANEL PLACEMENT FORM

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:
-----------------	---------------------------------------	------------------------------

[illegible]

TRIAL WELD INFORMATION

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:
-----------------	-----------------------------------	------------------------------

[illegible]

PANEL SEAMING CHECKLIST

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:
-----------------	-----------------------------------	------------------------------

DATE/ TIME	WEATHER/ WINDS	AMBIENT TEMP.	SEAMER INITIALS	MACHINE NUMBER	SEAM TYPE	SEAM NUMBER	PANEL NUMBERS	SEAM LENGTH	TEMP. SETTING	MACHINE SPEED	COMMENTS

NON-DESTRUCTIVE SEAM TEST LOG

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:
-----------------	---------------------------------------	------------------------------

[illegible]

DESTRUCTIVE SEAM TEST LOG

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:
-----------------	---------------------------------------	------------------------------

[illegible]

CERTIFICATE OF COMPLETION

TYPE: PARTIAL _____ SUBSTANTIAL _____ FINAL _____

PROJECT NAME: _____

SITE NAME: _____

DATE: _____

DESCRIPTION OF WORK CERTIFIED:

I HEREBY CERTIFY THAT THE ABOVE IDENTIFIED WORK HAS BEEN INSPECTED AND THAT IT HAS BEEN PROPERLY INSTALLED. I FURTHER CERTIFY THAT ALL REQUIRED TESTING HAS BEEN COMPLETED AND THE RESULTS HAVE BEEN DEEMED ACCEPTABLE BY THE GEOSYNTHETIC QAE. THE WORK IS SUITABLE FOR ITS INTENDED USE.

GEOSYNTHETIC QAE

SIGNATURE: _____ DATE: _____

NAME (PRINT): _____

TITLE: _____

REPRESENTING: _____

INSTALLER'S REPRESENTATIVE

SIGNATURE: _____ DATE: _____

NAME (PRINT): _____

TITLE: _____

REPRESENTING: _____

SOLUTIA REPRESENTATIVE

SIGNATURE: _____ DATE: _____

NAME (PRINT): _____

TITLE: _____

REPRESENTING: _____

**CERTIFICATE OF COMPLETION
OF SOIL SUBGRADE SURFACE**

DATE: _____

PROJECT NAME: _____

SITE NAME: _____

LOCATION OF SUBGRADE SURFACE TO BE LINED: _____

**I HEREBY CERTIFY THAT THE ABOVE AREA IS SUITABLE FOR THE
INSTALLATION OF GEOSYNTHETICS, AND THAT I SHALL BE RESPONSIBLE
FOR ITS INTEGRITY AND SUITABILITY IN ACCORDANCE WITH THE
SPECIFICATIONS FROM THIS DATE TO COMPLETION OF THE INSTALLATION.**

INSTALLER'S REPRESENTATIVE

NAME (PRINT): _____ **DATE:** _____

TITLE: _____

REPRESENTING: _____

SIGNATURE: _____

ACKNOWLEDGED BY:

GEOSYNTHETIC QUALITY ASSURANCE CONSULTANT

NAME (PRINT): _____ **DATE:** _____

TITLE: _____

REPRESENTING: _____

SIGNATURE: _____

ATTACHMENT 16
REVISED COVER SYSTEM HYDRAULIC CALCULATIONS

ATTACHMENT 16

Revised Sewer System Hydraulic
Calculations

URS Greiner Woodward Clyde

Job	Solutio Sought	Project No.	C10004051.00
Description	Cover System	Computed by	M. Brumgard
	Stormwater Control	Checked by	G. Ward
Page	1	Sheet	1
of	7	Date	12/9/00
Reference		Date	1-18-01

Purpose: Analyze rainfall & estimate stormwater flows from cell cover system. Design cover system features for route & control stormwater off the cover. This work is based on the previous cover system stormwater control calculations performed by M. Brumgard dated 5/12/00.

Assumptions: The cover area is about 356' x 356' or 291 acres. The 100-yr - 24-hr storm is 8.21 inches, the 50-yr - 24-hr storm is 7.07 inches, the 25-yr - 24-hr storm is 6.02 inches. Taken from "Frequency Distributions & Hydroclimatic Characteristics of Heavy Rainstorms in Illinois" by Huff & Angel, etc. 2-yr - 24-hr storm is 3.28 inches. The 2-yr storm is used in the SCS runoff method to estimate Time of Concentration. To get the hydraulic features of the stormwater system, the Graphical Peak Flow method from VR-55 will be used.

* Time of Concentration:

Sheet flow length = 300'
 Roughness Coeff. = 0.15 (grassy)
 No Shallow Flow Component
 Channel Flow Length = 700'
 Longest path around the cover perimeter.
 356' + 356' = 712' at 100'

Channel Slope = 0.01 = 1%
 Channel Roughness Coeff. = 0.032 (grassy)

$V_c = 0.36$ hrs (see attached QTR-55 printout)

* Peak Flow:

Rainfall Distribution Curve = Type II (grass over clay soil)
 Runoff Curve No. = 80
 Drainage Area = 291 ac

Event	25-yr	50-yr	100-yr
Rainfall	6.02 in	7.07 in	8.21 in
Peak Flow	11 cfs	13 cfs	16 cfs

(see attached QTR-55 printout)

URS Greiner Woodward Clyde

Job Solutio Sarged
Description Cover System
Stormwater Control

Project No. C100004051.00

Computed by M. Brungard

Checked by GHW

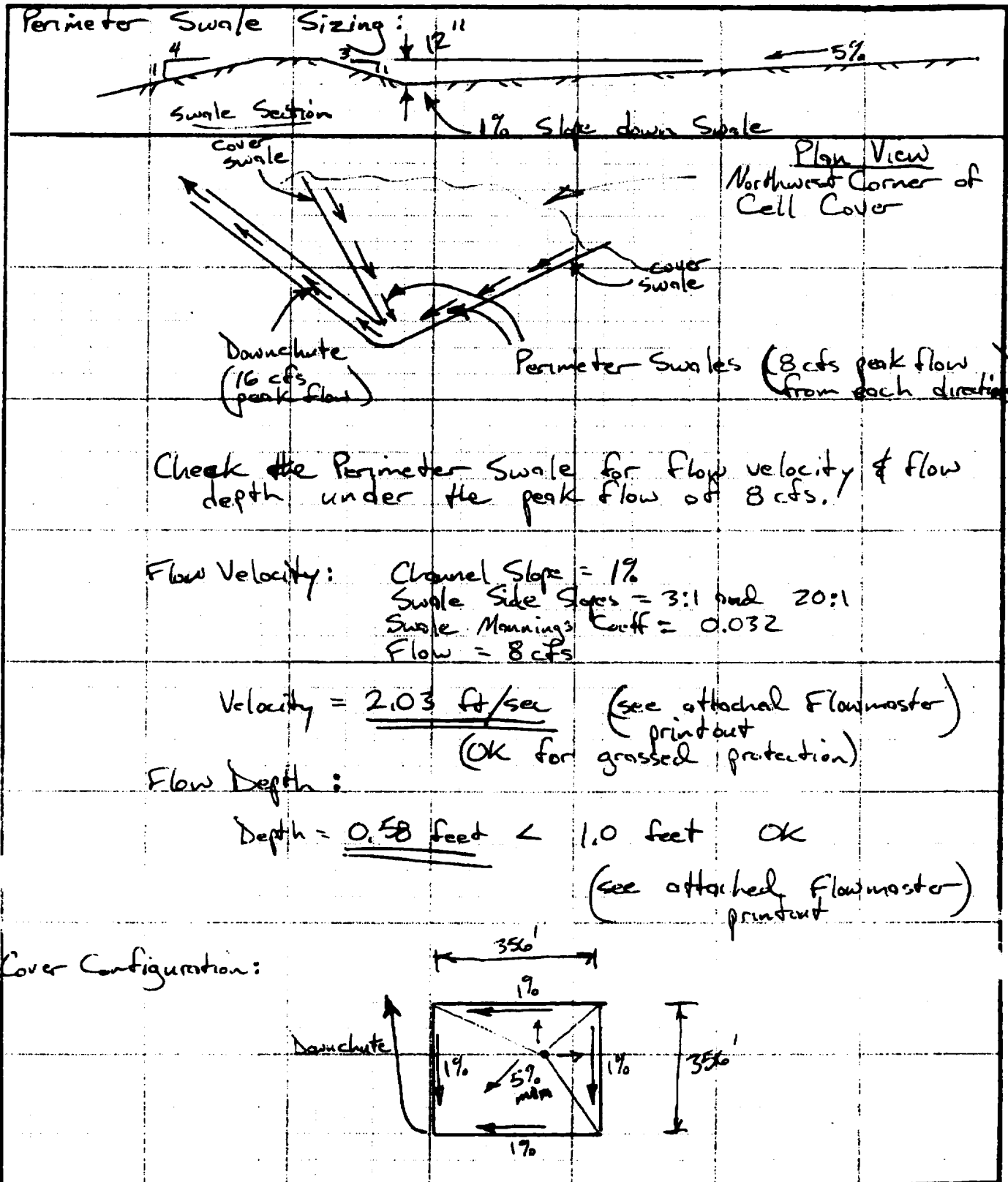
Page 2 of 7

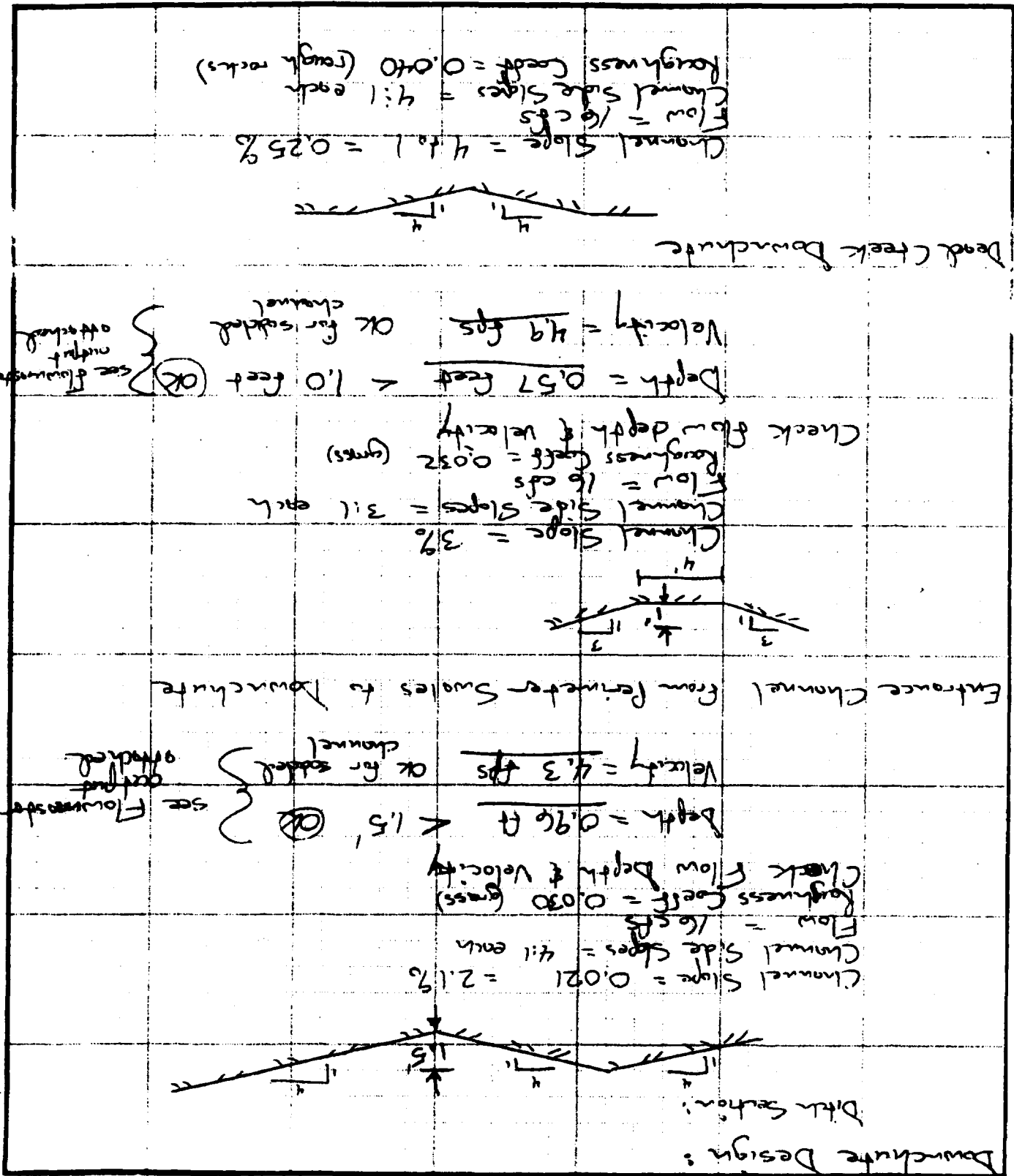
Sheet 2 of 7

Date 12/5/00

Date 1-10-01

Reference





URS Greiner Woodward Clyde		Job		Solutio Souded		Description	
				Cover System		Stemunder Control	
				Computed by M. Brungart		Checked by Gm	
Project No. C10004054.00		Sheet 3 of 7		Date 12/5/00		Date	
Page		Reference					

Entrance Channel into Downslope Channel Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\saugella.fm2
Worksheet	Entrance channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.030
Channel Slope	0.030000 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	3.000000 H : V
Bottom Width	4.00 ft
Discharge	16.00 cfs

Results	
Depth	0.57 ft
Flow Area	3.28 ft ²
Wetted Perimeter	7.62 ft
Top Width	7.44 ft
Critical Depth	0.67 ft
Critical Slope	0.017129 ft/ft
Velocity	4.89 ft/s
Velocity Head	0.37 ft
Specific Energy	0.94 ft
Froude Number	1.30
Flow is supercritical.	

Dead Creek Downchute Worksheet for Triangular Channel

Project Description	
Project File	c:\haestad\fmw\saugetta.fm2
Worksheet	Rip Rap Downchute into Dead Creek
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Slope

Input Data	
Mannings Coefficient	0.040
Depth	0.67 ft
Left Side Slope	4.000000 H : V
Right Side Slope	4.000000 H : V
Discharge	16.00 cfs

Results	
Channel Slope	0.257500 ft/ft
Flow Area	1.80 ft ²
Wetted Perimeter	5.52 ft
Top Width	5.36 ft
Critical Depth	1.00 ft
Critical Slope	0.030598 ft/ft
Velocity	8.91 ft/s
Velocity Head	1.23 ft
Specific Energy	1.90 ft
Froude Number	2.71
Flow is supercritical.	

Lateral Downslope Channel Worksheet for Triangular Channel

Project Description	
Project File	c:\haestad\fmw\saugelia.fm2
Worksheet	Solutia Saugel Lateral Downslope Channel
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.030
Channel Slope	0.021000 ft/ft
Left Side Slope	4.000000 H : V
Right Side Slope	4.000000 H : V
Discharge	11.00 cfs

Results		
Depth	0.84	ft
Flow Area	2.80	ft ²
Wetted Perimeter	6.90	ft
Top Width	6.69	ft
Critical Depth	0.86	ft
Critical Slope	0.018092	ft/ft
Velocity	3.93	ft/s
Velocity Head	0.24	ft
Specific Energy	1.08	ft
Froude Number	1.07	
Flow is supercritical.		

Cover Swale w/ 3:1 side and 5% side Worksheet for Triangular Channel

Project Description	
Project File	c:\haestad\fmw\sauguet.fm2
Worksheet	Solutia Sauguet Containment Cell Swales
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.032
Channel Slope	0.010000 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	20.000000 H : V
Discharge	8.00 cfs

Results	
Depth	0.58 ft
Flow Area	3.93 ft ²
Wetted Perimeter	13.56 ft
Top Width	13.45 ft
Critical Depth	0.50 ft
Critical Slope	0.024004 ft/ft
Velocity	2.03 ft/s
Velocity Head	0.06 ft
Specific Energy	0.65 ft
Froude Number	0.66
Flow is subcritical.	